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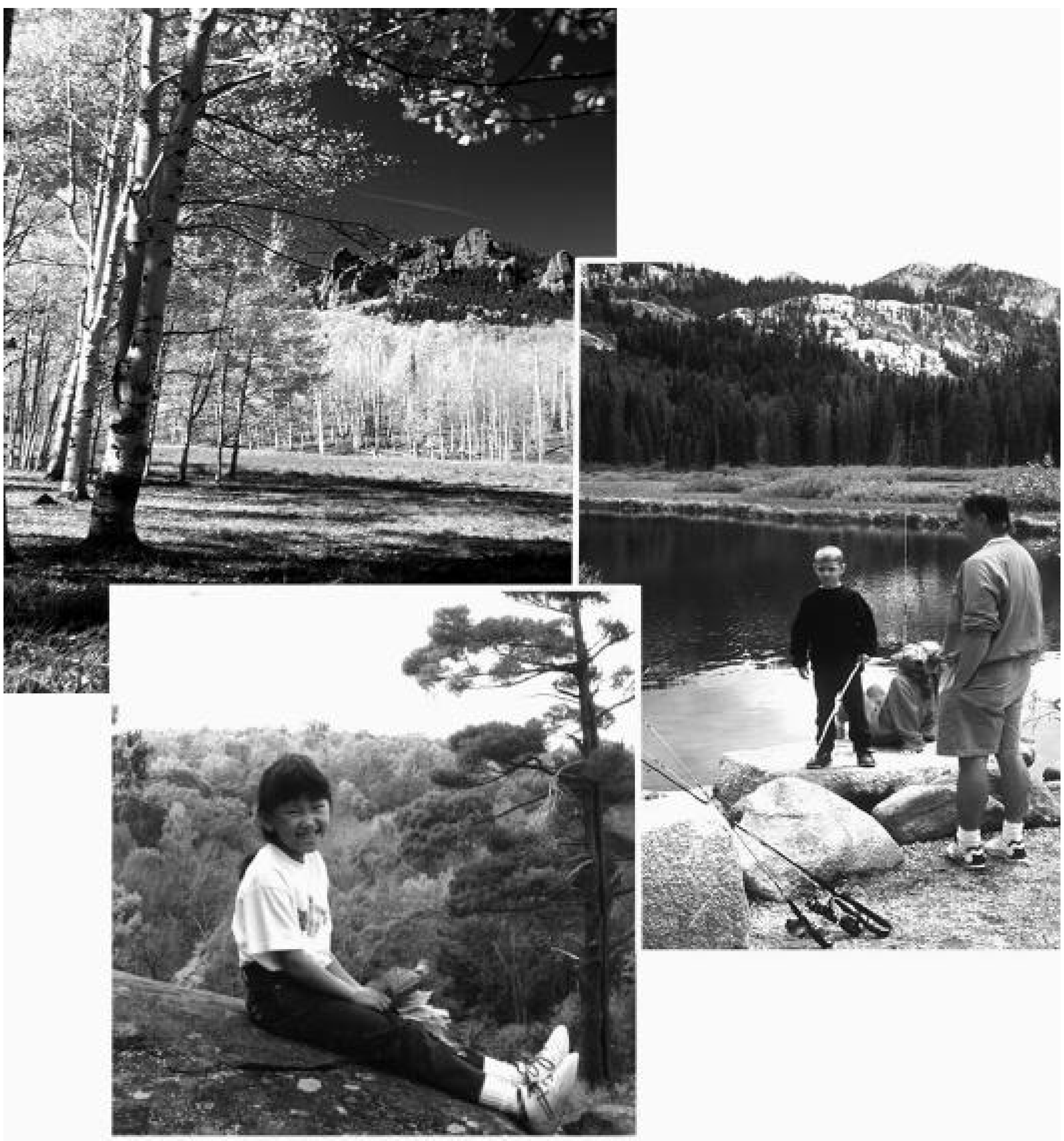
Final Environmental Impact Statement

Physical Resources Specialist Report



Physical Resources Specialist Report

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Abstract

This Physical Resources Specialist Report provides the detailed background and information analysis for the affected environment and environmental consequences of the alternatives analyzed in detail in Chapter 3 of the Forest Service Roadless Area Conservation Final Environmental Impact Statement (FEIS), November 2000. The analysis focuses on seven key measures to compare and contrast alternatives: (1) Water Quantity and Timing, (2) Water Quality and Drinking Water Source Areas, (3) Channel Morphology, (4) Soil Loss, Sedimentation, and Soil Productivity, (5) Landslides, (6) Fire Effects on Watersheds and Burned area Emergency Rehabilitation, and (7) Air Resources. The report contains an analysis of optional social and economic mitigation measures as well as an analysis of indirect and cumulative effects. The report focuses on the environmental consequences of four alternatives that would, to varying degrees, prohibit road construction and reconstruction and timber harvesting in inventoried roadless areas on National Forests and Grasslands. Of the four alternatives considered, Alternative 3 provides the most beneficial affects for water, soil, and air resources because it: (1) prohibits the most road construction and reconstruction, (2) prohibits timber harvest designed exclusively for commodity production purposes, (3) allows timber harvest for stewardship purposes, and (4) allows management practices that help minimize increases in large, severe wildfires that can damage water, soil, and air resources on National Forests and Grasslands as well as on adjacent and downstream lands managed by other entities.

Background and Proposal

Inventoried roadless areas comprise roughly 58.5 million acres, or roughly 31% of National Forest System (NFS) lands. Inventoried roadless areas have inherent characteristics and values that are becoming scarce in an increasingly developed landscape. While the NFS inventoried roadless areas represent about 2% of the total landbase of the United States, they provide significant opportunities for dispersed recreation, sources of public drinking water, and large undisturbed landscapes that provide privacy and seclusion. In addition, these areas serve as bulwarks against the spread of invasive species and often provide important habitat for rare plant and animal species, support the diversity of native species, and provide opportunities for monitoring and research. For a more complete description of the background and proposal see Chapter 1, *Purpose of and Need for Action,* in the FEIS.

To conserve inventoried roadless areas, the United States Department of Agriculture (USDA) Forest Service proposed and analyzed a range of alternatives to prohibit certain activities in these areas. The FEIS presents these alternatives to the deciding official to aid declaration of a final decision

The FEIS contains four prohibition alternatives, four Tongass alternatives, and a list of mandatory and optional exceptions that modify the alternatives to meet specific legal and other needs. See Chapter 2, *Alternatives Considered,* in the FEIS for a more detailed discussion of this information.

Analysis - Coverage

This analysis covers the effects of the Prohibition Alternatives and Tongass Alternatives. The general assumptions listed below cover all alternatives as do the general physical resources introductory statements. The affected environment narrative associated with each specific measure (water quantity and timing, landslides, etc.) applies to all alternatives. The affected environment narrative for each measure is immediately followed by a comparison of effects by alternative for that measure.

Analysis – General Methods

The analysis of effects of the various alternatives required a general rather than site-specific approach that might be employed for a project where the analyst has detailed, site-specific information on hydrology, soils, vegetation, geology, climate, and similar characteristics. This lack of specificity required a more general analysis of the likelihood of effects of various activities in regions of the country with similar characteristics such as those defined by Bailey (1995) or another grouping method.

The most efficient way to accomplish this task was through a literature review on the effects of various land management activities on water, soil, geology, vegetation, and air resources in these general regions of the nation. Fortunately, a vast array of literature is available on these topics from decades of research and administrative studies performed by government, university, industry, and other sources. The challenge was to synthesize the available knowledge and present it in a reader-friendly manner. A number of excellent synthesis papers were available that allowed an efficient analysis and presentation of available knowledge. Several works proved particularly valuable, including Anderson and others (1976), Chamberlin and others (1991), DeBano and others (2000), Elliot (In Press), Furniss and others (1991), Hornbeck and others (1993), Lull and Reinhart (1972), Neary and Hornbeck (1994), Sedell and others (2000), Swanston (1991), and USDA (2000h). These and other papers led to additional landmark studies that were sought out and included in this analysis.

Several measures (drinking water source areas, areas not meeting water quality standards, liklihood of soil loss and sedimentation, susceptibility to landslides, and Class I air quality areas) lent themselves to a general map analysis displaying liklihood of effects as they relate to specific watersheds, inventoried roadless areas, or both. In these cases overlays of map products were performed to highlight areas or watersheds of concern. More detail is given in an **Analysis Method Note** in the discussion of particular measures.

Changes Since the DEIS Specialist Report

Based largely on concerns identified during the Roadless Area Conservation Draft Environmental Impact Statement (DEIS) comment period, a number of improvements, additions, and changes were made that are reflected in the FEIS and this Physical Resources Specialist Report. Major changes are listed below.

Simplified Language: A specific effort was made to simplify terms through elimination of jargon and providing better explanations in the main body of the FEIS text and glossary. For example, the term, *mass wasting* was replaced with *landslides* since this term is more familiar to most people. *Watershed Health* was replaced with *Physical Resources* to be more specific and provide more recognition to important air resources.

Best Management Practices: Many members of the public were interested in seeing additional information in the FEIS related to the role of Best Management Practices (BMPs) in controlling nonpoint source pollution from road construction, reconstruction, timber harvest, and related activities. The FEIS and this report contain a more thorough discussion of BMPs.

Landslide Susceptibility Acres: Additional and refined information from forests and regions, particularly in relation to special designated areas, revised the acreage estimates for inventoried roadless areas from approximately 54 million acres in the DEIS to approximately 58.5 million acres in the FEIS. A rerun of the overlays of landslide susceptible lands with the revised inventoried roadless area acreage resulted in a revision of Table 3-9 in the FEIS and Table 1 in this report.

Fire Effects on Watersheds and Burned Area Emergency Rehabilitation: The extremely active 2000 fire season placed a special emphasis on fire-related analysis in the FEIS. This is particularly true following concern generated by the Cerro Grande fire that burned around and into the Los Alamos National Laboratory and the city of Los Alamos, New Mexico. The discussions of fire effects on watersheds as well as Burned Area Emergency Rehabilitation (BAER) were strengthened considerably in the FEIS.

Class I Area Map: Commentors pointed out two inadequacies in the map displayed as Figure 3-16 in the DEIS that shows Class I air quality protection areas: (1) The map depicted more Class I areas than actually exist, and (2) the small size of the map scale made it difficult to read and interpret. The revised map in the FEIS (Figure 3-19) and in this report (Figure 5) show the correct number of areas and locations, and the figure is shown at full-page scale to improve readability and interpretation.

Global Climate Change and Carbon Sequestration: Many members of the public expressed concern over the potential effects of the alternatives on Global Climate Change and Carbon Sequestration, which the DEIS did not address. The FEIS and this report address these issues at some length in the Air Resources section, supported by numerous additional references.

Social and Economic Mitigations: The FEIS considers an exception for road construction and resonstruction for minerals exploration activities to mitigate social and economic impacts on this industry should road construction and reconstruction prohibitions eliminate these activities. The FEIS and this report discuss the environmental effects of these mitigation measures.

Indirect and Cumulative Effects: The DEIS contained a somewhat limited analysis of cumulative effects related to physical resources. The FEIS contains a more thorough analysis of these effects. This specialist report contains a further expanded version of the analysis presented in the FEIS.

Hydrologic Unit Code Description: To aid reader understanding of the heirarchy of hydrologic unit codes (HUCs), and how they relate to the alternatives and cumulative effects, this report contains a brief description of HUCs along with an example to illustrate how these hydrologic units are used at the national forest and rangeland level. This description is located in the section on indirect and cumulative effects.

References: The expanded sections on BMPs, Global Climate Change/Carbon Sequestration, Fire Effects, BAER, and Social and Economic Mitigations resulted in a substantial number of additional references to address these topics. Several additional references recommended by the public are also included.

Glossary: The FEIS expanded the Glossary of terms to help readers better understand the document. Key glossary terms relative to physical resources are included in this specialist report.

Assumptions - General

Population - Growing populations in urban and rural areas will increase demand for reliable quantities of high quality water for domestic and industrial purposes. This is generally true across the nation but particularly in the Southeast, south-central States, Intermountain West, and Pacific Southwest. The Lower Colorado, Great Basin, Pacific Northwest, and California water resource regions each obtain significant portions of their water from NFS lands (Sedell and others 2000).

Water Supply - Nearly 3,400 communities currently obtain water from watersheds containing NFS lands (Sedell and others 2000). The number of communities and the number of total users of water flowing from watersheds containing NFS lands will continue to increase. In the West, NFS lands often occupy a significant portion of a watershed, while NFS lands in the East commonly occupy only a small percentage or very headwaters of source watersheds.

Watershed Size - Land management activities can favorably or adversely affect water, soil, and air resources. The probability of measuring and detecting the effects of many activities on watershed resources, such as temperature or water yield changes, generally increases as the size of the watershed decreases. The effect of a specific activity may be undetectable within a larger 4th level (approximately 500,000 acre) watershed but that same activity may be detectable in a smaller 6^{th} level (approximately 10,000 to 50,000 acre) watershed. This effect is mainly due to the percent of total treated area within a given watershed. This may not be true for all parameters, however. For example, channel aggradation may not be evident in steep headwaters streams but becomes measurable in lower gradient sections of larger watersheds.

Proximity to Water - The potential risk of an activity effecting watershed resources generally increases with proximity to the water body itself. Roads or harvest units adjacent to or near water bodies generally have a higher likelihood of impacting the water than a similar activity further away from the water. Impacts from events like landslides, may be evident many miles downstream, however.

Harvest Unit Activities - Timber harvest sale areas may include one or more harvest units. The harvest unit includes two general types of activities that may affect water, soil, and air resources: (1) the cutting of the trees themselves, producing logs and slash, and (2) the transportation system within the harvest unit to move logs and other materials to the designated road system. This transportation system within the harvest unit may include trails made by skidders or felling and bunching equipment, skid roads, skid trails, log decks or log landings, setup points for cable yarding systems, and connecting spur roads. The effects from cutting the trees can have environmental effects in addition to the internal transportation system needed to move harvested materials to the mill. The skid roads, landings, and similar transportation links associated with the harvest unit are separate from the classified roads considered in this proposal. Classified roads are designed and constructed to different standards and, as such, have separate environmental effects.

Road and Drainage Networks - Drainage patterns and roads are both networks, but they generally run perpendicular to each other i.e. roads usually cut across slopes while streams flow down slopes. Understanding the interaction of these networks is key to estimating road effects of watersheds (Wemple and others, 1996). Common effects of roads on watersheds occur where roads intersect drainages. A dense road network interacting with a dense stream network will have a higher likelihood of effects than a limited road network overlaying a sparse drainage pattern. A complicating factor in steep terrain is the movement of landslide debris initiated by roads moving far from the point of origin. Roads located adjacent to water bodies are often a direct source of sediments and other pollutants and increased flow volume.

BMPs and Contract Requirements - Using the most up-to-date BMPs for the design, operation, and maintenance of forest roads and timber harvest will prevent or mitigate most significant impacts to watershed resources. BMPs represent the state of current knowledge on preventing pollution from non-point sources. However, roads and timber harvest activities can still have long-term impacts on physical and biological watershed resources, particularly where precipitation and runoff events exceed the design criteria of the BMPs implemented.

Ground Disturbing Activities - Keeping soil in place by preventing erosion by water or wind is paramount to maintaining healthy watersheds and airsheds. Preserving ground cover is generally the most effective means of preventing accelerated erosion. Alternatives that limit ground-disturbing activities are generally preferable from a water, soil, and air resources standpoint.

Stewardship Treatments - Alternatives that allow timber harvest for stewardship reasons would enable managers to implement actions to treat insect and disease outbreaks and reduce the risk of large, damaging wildfire and the resultant effects on water, soil, and air resources. Alternatives that completely prohibit tree cutting could limit managers' treatment options in high-risk areas.

Large Fire Rehabilitation - A strong positive correlation exists between the number of large, damaging wildfires and the need to implement Burned Area Emergency Rehabilitation (BAER) evaluations and treatments. Years or regions with few large fires have few BAER actions while years or regions with lots of these fires have substantial BAER activity. Alternatives that result in more, large damaging wildfires will likely have more BAER activity.

Physical Resources

Water, soil, and air resources have measurable characteristics that operate within naturally variable ranges of values. Water yield, timing, and quality, soil erosion, air quality, and other characteristics can vary widely, even in undisturbed situations. Land management practices, such as road construction and reconstruction, timber harvest, prescribed burning, and other similar activities, can affect these values, and their variability. Sometimes the effects are within natural ranges; sometimes they are not. The most common effects of road construction and reconstruction and timber harvest activities on water, soil, and air resources are loss of ground cover vegetation, soil erosion and compaction, loss of soil productivity, increased potential for landslides, reduced transpiration (use of water by plants), increased water runoff, reduced water quality, and reduced air quality. In this analysis, the specific characteristics discussed are water quantity and timing, water quality and drinking water source areas, channel morphology, soil loss and sedimentation, site productivity, landslides, air resources, effects of fire on watersheds and burned area emergency rehabilitation.

Roads have long been recognized as the primary human-caused source of soil and water disturbances in forested environments (Patric 1976; Egan and others 1996). Most impacts occur during initial road construction and then gradually decrease as roadside vegetation is reestablished and disturbed soil surfaces stabilize. Effects, such as landslides, may persist when a road permanently undercuts unstable soils or landforms, or when roads are disturbed by road maintenance. Periodic maintenance activities can cause some of the impacts to briefly, but repeatedly, recur. Areas of particular concern are the road surface and associated drainage structures such as ditches and water crossings (bridges, culverts, and fords). Poorly maintained roads can result in greater impacts as surface water is diverted, culverts plug, and other road design characteristics are compromised. Lack of maintenance commonly has detrimental effects on water, soil, and air resources. Insufficient maintenance funding is a key reason for lack of adequate road maintenance (USDA Forest Service 2000h).

Temporary road construction has most of the same effects as permanent road construction but generally for a shorter term and for a more limited physical extent. Long-term effects can occur if temporary roads receive extended use, and they are not decommissioned. Generation of sediment within timber harvest units is most strongly related to roading and associated facilities (skid roads and trails, log landings, etc.) that are needed to remove logs, as opposed to tree cutting (Anderson and others 1976). Skid roads and trails, log landings, and similar disturbances within the sale area are the main cause of soil erosion and can contribute up to 90% of the sediment generated by timber sale activity (Patric 1976; Swift 1988).

Until recently, poorly managed timber harvest activities have been a major source of sediment from timber sale areas (Stone and others 1979; Martin and Hornbeck 1994). Generally, monitoring has shown compliance rates for implementing best management practices to be between 85% and 98%, with compliance rates increasing over time as awareness and training programs take effect (Stuart 1996; State of Oregon 1999; State of Montana 1998; Phillips and others 2000). Results vary between States and ownerships, with Federal lands and large forest industry entities showing highest compliance, but small non-industrial landowners with little access to professional forestry assistance falling behind. A recent report from Oregon found overall compliance rates of 98% to 99% across all ownership classes (State of Oregon 1999), while a study in Maine reported only 34% of BMPs with compliance rates grater than 80% (State of Montana 1998; University of Maine 1996).

Although, BMPs do not completely eliminate water quality impacts, they do reduce impacts to acceptable levels. "Best management practices may not be completely effective, but they do provide a level of protection that the states and the Environmental Protection Agency judged sufficient to meet the goals of the Clean Water Act" (Ice and others 1997). "Audit results showed that 96 percent of the individual practices audited were effective in protecting soil and water resources" (State of Montana 1998). "When used, the forestry BMPs work well" (University of Maine 1996). Concern remains in some aspects of BMP compliance, however. For example, reports from Maine, Montana and Oregon all cited below average compliance rates with road maintenance, road drainage, and temporary crossings (State of Montana 1998; University of Maine 1996; State of Oregon 1999). These aspects of BMP compliance may require additional education and compliance reviews. Although some excellent work is under way on assessing the effectiveness of best management practices, additional work is need is this area (Seyedbagheri 1996).

Currently, all Forest Service permanent and temporary roads needed for timber sales are designed and constructed using water, soil, and air BMPs that meet or exceed those required by individual States under Environmental Protection Agency (EPA) direction. Current road design and management criteria incorporate the latest knowledge and experience, resulting in fewer effects, such as surface erosion, landslides, sedimentation, and dust emissions, on water, soil, and air resources. Proper design and construction of new roads and maintenance of existing and new roads can limit but not eliminate these effects (USDA Forest Service 2000h).

Water Quantity and Timing

Affected Environment

Water flowing from NFS lands comprises about 14% of the total annual average water yield in the United States. This contribution is roughly 3% in the East and 33% in the West (Sedell and others 2000).

Roads affect the quantity and timing of stream flow by intercepting, concentrating, and diverting runoff (Furniss and others 1991; USDA Forest Service 2000h). They can indirectly affect annual flow volume, since they replace trees that use water. Water otherwise used by trees would become available for runoff or entry into the soil.

Water Quantity – Most experts concur that the relative effects of individual timber harvesting and roading activities on flooding decreases as watershed size increases. The extra flow generated in smaller watersheds becomes less evident as it joins flows from other watersheds and continues downstream (Anderson and others 1976; Stone and others 1979; Hewlett and Doss 1984; Thomas and Megahan 1998; Ziemer 1998; Elliot in press). Similarly, numerous harvest units and roads in multiple sub-watersheds of a larger watershed generally do not yield proportional increases in floods. Additional water from smaller units enters the main stream at different times. This action desynchronizes the flows, moderating net flow increases.

Effects of land uses, such as timber harvest and roading, are more evident during small and moderate storm events but are less important in large storm events (Hewlett 1982; Bosch and Hewlett 1982). Large runoff events are generally the result of large volume or extended periods of precipitation or snowmelt runoff that exceed the capacity of the soil to hold additional water (Lull and Reinhart 1972; Swanston 1991). This is true regardless of the land use practices.

Timber harvests can cause an increase in total annual water yield, whereas roads are unlikely to have a similar effect, mainly because harvests tend to cover more area than roads (USDA Forest Service 2000h). Changes in total annual water yield would most likely be detected where there is abundant moisture to begin with, and where the soil has less ability to absorb additional water such as in the coastal forests of California, Oregon, Washington, and Alaska (Regions 5, 6, and 10) (Harr 1983; Kattelmann and others 1983; Ziemer 1987). Studies in Eastern forests indicate that at least 20% to 25% of the basal area in a given watershed must be removed to produce detectable increases in annual flow (Douglass 1967; Hornbeck and others 1993).

Changes in total annual water yield are generally less detectable in the drier climates of the Interior West and Southwest where additional water is quickly used by the remaining plants or is lost through evaporation (Schmidt and Solomon 1983). Harvest levels on NFS lands in the Southern and Eastern regions (Regions 8 and 9) are generally too small to generate measurable change (Hornbeck and others 1993; Lull and Reinhardt 1972). Water-yield returning to normal levels is in direct proportion to how quickly the site revegetates. Regrowth in the East and in humid parts of the West is rapid, and flows return to normal levels 6 to 10 years after harvest. Slower growth in drier parts of the country may extend the recovery period to at least twice as long as that expected in wetter regions of the U.S. (Stone and others 1979).

Runoff Timing – Timing of water runoff (how quickly a watershed generates runoff and the time it takes for that water to travel downstream) can change as roads and related drainage structures intercept, collect, and divert water. This accelerates water delivery to the stream, more water becomes storm runoff, which increases the potential for runoff peaks to occur earlier, be of greater magnitude, and recede more quickly than in unroaded watersheds (Wemple and others 1996).

Vegetation cover removal through timber harvest can also change flow timing. In conifer forests, such as in the Intermountain West, where the majority of precipitation is snowfall, openings in the forest canopy can capture more snow and deliver it earlier during spring runoff (Leaf 1975; Troendle and King 1985; Troendle and King 1987). In rain-dominated Western conifer forests, flows from harvested areas are greater toward the end of the summer dry period than are flows from uncut forests, but the flow difference is minimal once soils are resaturated by fall rains (Ziemer 1998). Harvesting hardwood forests and areas that receive the majority of precipitation from rainfall delivers more water in the late summer or early fall. This pattern can supplement low flows during these times and can be beneficial to fish and other aquatic organisms during water-stress periods (Anderson and others 1976; Stone and others 1979; Swank and others 1988; Kochenderfer and Hornbeck 1999).

Changes in water timing are most likely to occur in areas with large amounts of timber harvest and roading since these activities have the highest potential to alter natural hydrologic processes. Areas with greater variability in seasonal precipitation and runoff, such as the arid and semi-arid portions of the West, are more sensitive to changes in flow timing than areas with more even rates of precipitation and runoff such as the humid portions of California, Oregon, and Washington, and the Eastern United States. Changes in the magnitude of flood peaks and seasonal low flows are more evident in drier climates (Neary and Hornbeck 1994). The Northern, Intermountain, and Pacific Northwest Regions, respectively (Regions 1, 4, and drier portions of 6) are most likely to experience early runoff during a storm, since they have relatively high planned harvest levels and are located in drier climates. Even though the Alaskan region (Region 10) has the largest volume of scheduled timber harvest in inventoried roadless areas, its yearlong precipitation would make any potential changes in runoff peaks or timing difficult to detect.

The USDA publication, *"Forest Service Roads: A Synthesis of Scientific Information,"* (USDA Forest Service 2000h) summarizes most of the effects of roading and timber harvests on hydrologic regimes.

> Collectively, these studies suggest that the effect of roads on basin stream flow is generally smaller than the effect of forest cutting, primarily because the area occupied by roads is much smaller than that occupied by harvest operations. Generally, hydrologic recovery after road building takes much longer than after forest harvest because roads modify physical hydrologic pathways but harvesting principally affects evapotranspiration processes.

Alternative 1 – No Action

NFS lands data shows 1,160 miles of planned roads through 2004 for both timber harvest (623 miles) and other activities (537 miles). Forests also plan to offer 1.1 BBF (billion board feet) of timber during this same period. Region 10 accounts for the largest portion of the timber offer (49%), followed by Region 4 (18%), and Regions 6 and 1 (8% each). Region 10 also plans to build the most roads (31%), followed by Region 4 (23%), Region 1 (12%), and Region 2 (11%).

Roads and timber harvest activities would be designed and implemented to meet all applicable BMPs and timber sale contract requirements, since adherence to these principles is important to maintaining optimal water yield and timing from the disturbed area. However, since BMPs and sale requirements are designed for specific maximum storm/runoff events, storms or runoff that exceed these parameters have some risk of causing on-site or downstream adverse effects.

Average annual water yields would most likely increase where annual precipitation is abundant (although difficult to detect), such as the coastal portions of Regions 5 and 6 and on the Tongass National Forest. Average annual water-yield volumes would not be likely to change in the drier portions of the Interior West, even where harvests would be heaviest, or in the East where harvest volumes and roading would be modest.

Regions 1 and 4 would be the most likely to experience increases in flood flows, especially where harvest units or roads are located in small headwater areas and also during small and moderate storm events in late summer.

Alternative 2

This alternative would eliminate roughly 75% of planned road construction (867 miles) and about 73% of the planned timber offer (840 MMBF [million board feet]) in inventoried roadless areas through the year 2004. The remaining 25% of road miles are exempt from the prohibitions for a variety of reasons. The reduction in road miles would reduce disturbance the most in humid areas with high stream densities that require the most drainage structures and crossings such as the wetter parts of Regions 5 and 6 and Regions 8, 9, and 10.

Reductions in timber offer would be dramatic in Region 10 with a 95% drop (512 MMBF), followed by a 67% drop in Regions 4 (134 MMBF), and a 49% drop in Region 9 (39 MMBF). Compared to Alternative 1, flood flow changes in Regions 4 and 1 would be less likely due to lowered timber harvests. Detecting changes in flood flows, especially larger flow events, would be less likely in other parts of the country. Average annual water yields, even in humid parts of the country, would be closer to those found in undisturbed forests due to the reduced timber harvest.

Alternative 3

The effects of this alternative on water quantity and timing would be similar to those under Alternative 2. Reductions in roading are the same, but elimination of all offered timber, except for stewardship purposes, drops the offer levels approximately 85%, and virtually eliminates harvests in Region 10, which has little opportunity for stewardship harvests. Flood flows and average annual water yields would be closer to undisturbed levels than those under Alternative 2 and would likely be at undisturbed levels in Region 10.

Alternative 4

Under this alternative, there would be the same drop in road construction as that under Alternatives 2 and 3, but with elimination of timber offered for commodity and stewardship purposes. Water quantity and timing, flood flows, and average annual water yields would be the closest to undisturbed levels under this alternative. A slightly increased probability of large fires could increase flood flows and change runoff timing from burned areas.

Water Quality and Drinking Water Source Areas

Affected Environment

Road construction and reconstruction and timber harvest can result in measurable reductions of water quality by introducing sediment and nutrients, causing abnormal temperature fluctuations, and through the indirect effects from human use. Site preparation activities (mechanical, hand treatment, fire, etc.) following timber sales to prepare the harvested area for either natural or artificial regeneration can also affect water quality although the extent and severity of these activities on NFS lands has decreased with the reduction in harvest levels and intensity of harvests. Some pollutants are from road construction and maintenance equipment, or are brought into the watershed through public road use.

Temperature – Road construction and reconstruction and timber harvest may cause water temperature to change where groundwater is intercepted and brought to the surface, where the stream channel shape is wider or shallower, or where loss of tree cover in riparian areas reduces shading (Hornbeck and Leak 1992). Temperatures may rise sharply in exposed areas and some of those elevated temperatures may then return to normal levels as water re-enters shaded areas downstream or receives cool inflow from other streams or groundwater (Pierce and others 1993). Smaller or shallower streams are generally more susceptible to temperature fluctuations than larger or deeper streams (Chamberlin and others 1991).

Nutrients – Roading and timber harvest may indirectly affect water quality by increasing the release of certain nutrients from the decomposition of timber harvest byproducts (leaves, branches, and other organic matter). Nutrients, such as nitrogen, phosphorous, potassium, and calcium, may increase in stream water following timber management activities. Nitrogen generally shows the most abrupt changes. Tree cutting has less effect than subsequent site preparation activities that are used to expedite regeneration (Hornbeck and Leak 1992). Elevated nutrient levels in streamflow usually return to normal in 1 to 4 years (Chamberlin and others 1991).

The U.S. Environmental Protection Agency (EPA) delegates the responsibility to implement the Clean Water Act to States and Tribes. The Forest Service works closely with States and Tribes to assure Agency management practices comply with their requirements. Per agreements with many States, the Forest Service is the designated water-quality management agency for NFS lands. These agreements include specific procedures to apply if water quality problems are discovered.

Section 303(d) of the Clean Water Act requires States to evaluate water quality in light of State water-quality standards, report those stream segments that are impaired, and requires development of a total maximum daily load of pollutants. Although a recent publication by the Society of American Foresters (2000) raises some concerns over the accuracy and applicability of 303(d) lists as they pertain to forest management as a source of nonpoint source pollution, these lists still serve a role in focusing pollution control efforts in rural areas. Many States have identified impaired stream segments on NFS lands, and they are working with the Forest Service to determine how to reduce pollutant impacts and meet total maximum daily load requirements. On NFS lands, many of the recognized impairments are from sediment, temperature, nutrients, and similar pollutants (U.S. Environmental Protection Agency 1997).

Figure 2 identifies major watersheds with impaired waters that also contain inventoried roadless areas on NFS lands. Although the percentage of impaired stream miles within the watersheds is noted, it does not imply that the impairments were the result of activities on NFS lands within the watersheds. The impaired stream miles listed below may come from any ownership within the watershed. Of the 533 watersheds with impaired waters, 356 (67%) have between 1% and 10% impairment, 146 (27%) have between 11% and 25% impairment, and 31 (6%) have more than a 25% impairment. The map shows watersheds with water quality concerns and provides a basis for evaluating the likelihood of impact by implementing additional land management activities.

Drinking Water Source Areas – There are more than 2,000 major watersheds in the United States and Puerto Rico. Of these watersheds, 914 contain some NFS lands, and 661 of those contain inventoried roadless areas. Stepping this number down farther, 354 (55%) are source areas that provide water to facilities that treat and distribute drinking water to the public (U.S. Environmental Protection Agency 1997; Sedell and others 2000.) No data exist for Alaska, Hawaii, or Puerto Rico). About 150 of the source watersheds in Figure 1 have some use restrictions, such as the watersheds that service Santa Fe, New Mexico; Portland, Oregon; and Seattle, Washington. Most others provide a wide range of multiple uses. As required by the 1996 amendments to the Safe Drinking Water Act (U.S. Environmental Protection Agency 1997) all watersheds that provide public drinking water will be delineated, assessed for risks, and reported to the EPA by May 2003.

> **Analysis Method Note:** Figure 1 was created by overlaying the Roadless GIS database of inventoried roadless areas and the EPA database of watersheds that are drinking water source areas. Watershed boundaries are taken from the EPA Index of Watershed Indicators (USEPA 1997), which uses boundaries provided by the US Geological Survey. Figure 1 shows only watersheds that (1) have NFS lands, (2) have inventoried roadless areas on those lands, and (3) yield water to treatment facilities that provide drinking water for public use. The EPA drinking water database (USEPA 1999a) does not contain information for Alaska or Puerto Rico.

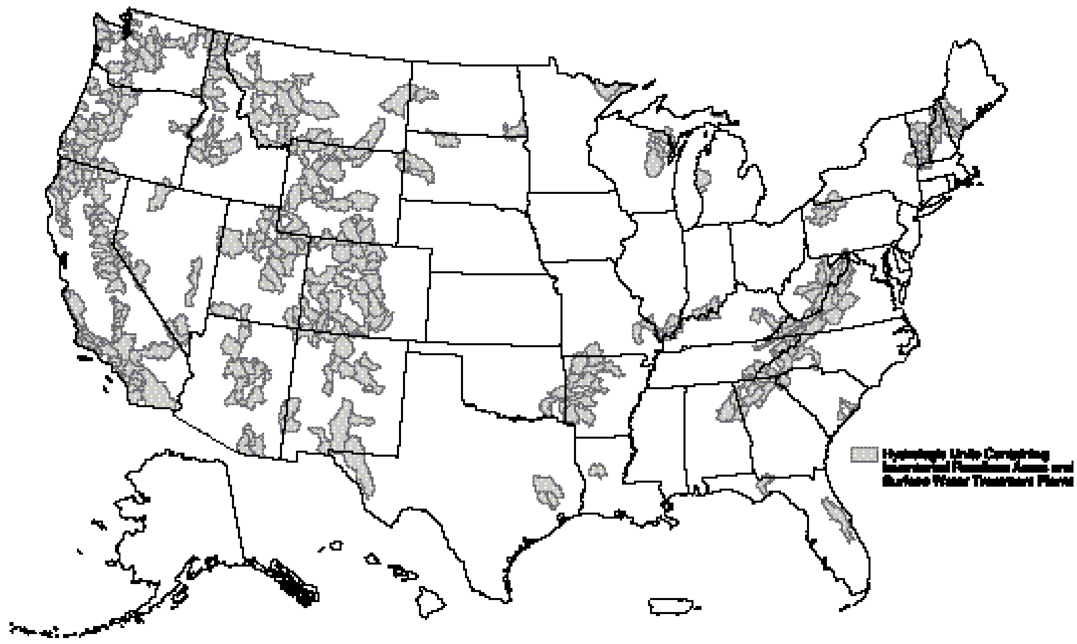

Figure 1. Watersheds containing drinking water source areas within inventoried roadless areas on National Forest System lands.

(Roadless Database 2000; U.S. Environmental Protection Agency 1997)

Analysis Method Note: Figure 2 was created by overlaying the Roadless GIS database of inventoried roadless areas with watershed boundaries in the EPA Index of Watershed Indicators (USEPA 1997), and the EPA database of watersheds with Clean Water Act Section 303(d) violations (USEPA 1999b). Figure 2 shows only those watersheds that (1) contain NFS lands, (2) have inventoried roadless areas on those lands, and (3) have known water quality values in violation of state water quality standards within the watershed regardless of land use or ownership. The UEPA groups data into five categories of percentage ranges of stream miles within a watershed that fail to meet water quality standards: 0 percent, less than 5%, 5 to 10%, 11 to 25%, and more than 2%. Figure 2 does not show the 0% class, combines the next two classes into a 1 to 10% class, and displays the remaining two classes as depicted by EPA. Showing three classes in Figure 2 avoids difficulty in displaying five classes of gray scale in the black and white printed FEIS and allows the reader to focus on the watersheds of concern where water quality problems are greatest. This analysis was performed to display watersheds that already have water quality concerns regardless of ownership or land use. The analysis of effects assumes that alternatives with the least ground disturbing activities will also be the least likely to exacerbate water quality in watersheds with existing problems.

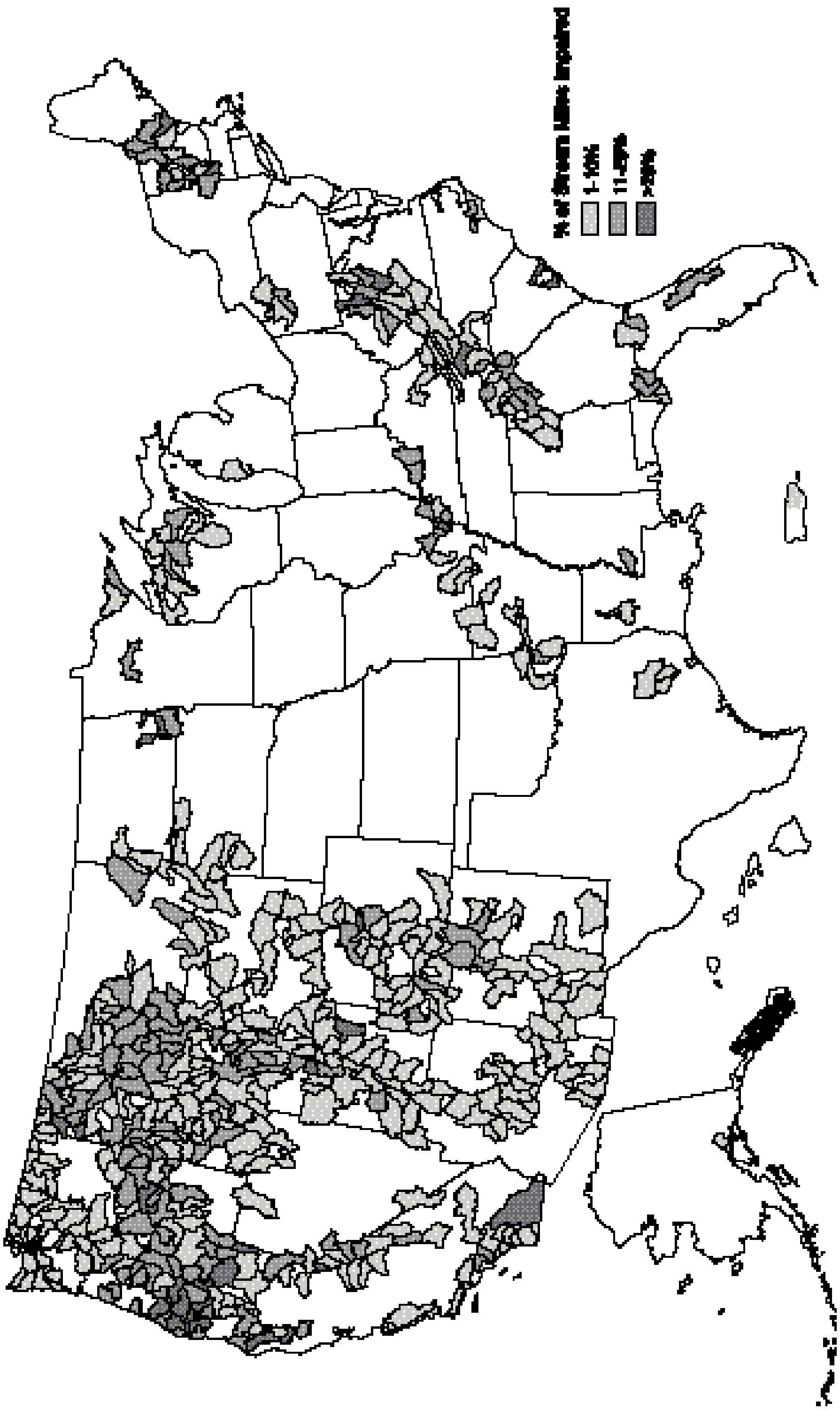

Figure 2. Impaired watersheds that contain inventoried roadless areas.

(Roadless Database 2000; U.S. Environmental Protection Agency 1997)

Alternative 1 – No Action

This alternative has the highest levels of timber offer and roading and therefore, has the highest probability of changes to water quality compared to the other alternatives. Although these ground-disturbing activities are closely monitored and use BMPs, the highest likelihood of water quality impacts is in the less frequent but higher volume precipitation and runoff events. In Regions 5, 6, and 10, and the wetter parts of Regions 1 and 4, high runoff can be caused by rain-on-snow events and large storms that sweep in off the Pacific Ocean. The harvest and roading levels in Regions 10, 4, and 1, respectively, and in several coastal forests in Regions 5 and 6, are most subject to these events and thus, have a high probability of impacting water quality.

In the drier parts of the Intermountain West and Southwest, rapid spring snowmelt runoff and intense spring and summer thunderstorms produce the most runoff and elevated flood peaks. High-risk seasons in the East are infrequent rain-on-snow events in the late winter and early spring, violent thunderstorms in the late spring to early fall, and precipitation from tropical storms and hurricanes along the Gulf Coast and the Atlantic Seaboard. The highest likelihood of changes to water quality occurs in these key regions during periods of high risk of erosion and runoff. Adding miles to the already under-maintained miles of NFS roads would increase the probability of additional water quality impacts.

Road construction, reconstruction, maintenance, and timber harvest activities affect watersheds. There is particular concern for watersheds that serve as drinking water source areas. Roads tend to contribute sediment, while timber harvest contributes sediment and nutrients. Due to the high level of roading and timber harvest, the greatest likelihood of impacts to watersheds that are drinking water sources is in New Hampshire (White Mountains), Virginia, West Virginia, Georgia, Tennessee, North Carolina (Appalachian Mountains), Oregon and Washington (Cascades), Idaho, western Montana, western Wyoming; the Sierras, and California (northern coast).

The most common concern with impaired waters in forested lands is that sediment loads, nutrients, or temperature changes might further degrade water quality. Timber harvest operations and roading can affect these water quality parameters, especially during high runoff events. Based on the planned roading and timber offer levels, the highest likelihood of water quality impacts is in the forests of Vermont and New Hampshire, Virginia and West Virginia, north Georgia, Idaho and western Montana, eastern and southwest Oregon, and coastal northern California.

Alternative 2

The elimination of about 75% of the planned roading and the associated 73% reduction in timber offer would affect water quality, particularly in regions and areas highlighted in Alternative 1. Lower roading and timber offer levels would reduce concerns for increased sediment and nutrients in drinking water source watersheds. Concerns for increased sediment, nutrients, and temperature in watersheds with identified impaired water quality requiring total maximum daily loads would also be reduced. Under this alternative, there would be fewer new road miles needing periodic maintenance.

Alternative 3

This alternative would have the same reductions in roading as those under Alternative 2, but it would further reduce the likelihood of logging impacts by allowing only stewardship harvests. Even though Region 10 has little opportunity for stewardship harvest, the region reports that 52 miles of road construction and reconstruction are tied to non-timber activities and would likely remain open, causing some concern for water quality. Similarly, Region 1 would offer only 20% of its planned volume but would still construct or reconstruct 72 miles (52%) of planned roads.

Alternative 4

This alternative would eliminate timber offered for commodity and stewardship purposes. Reductions in roading are the same as those under Alternatives 2 and 3. The incremental reduction in harvest would have fewer effects compared to those under Alternative 3. A slightly increased probability of large fires could affect the quality of water from burned areas.

Channel Morphology

Affected Environment

Roading and vegetation management have the potential to change stream channel morphology (structure and form). Unaltered streams normally exist in a state of dynamic equilibrium where stream shape (slope, width, depth, sinuosity) adjusts to incremental changes in sediment and water inputs but retains the same general shape over time (Lane 1955; Heede 1980). Sizable changes in sediment and water inputs can throw the channel out of equilibrium, causing it to adjust to a different form with different functions and values (DeBano and Schmidt 1989a,b; LaFayette and DeBano 1990; Furniss and others 1991; Rosgen 1996).

Stream systems or segments can exhibit vertical instability (down cutting or filling of the channel) or lateral instability (increases or decreases in stream width). Large additions of sediment or decreased flow of water can reduce a stream's ability to transport the available sediment, causing the channel to aggrade (fill). Sediment inputs from landslides or reductions in water flow are examples of adjustments that can cause these changes. Reducing normal sediment loads or increasing the flow in a stream can increase sediment transport and cause the channel to degrade (cut into its bed or banks). Increasing flow into a channel from road ditch placement or when timber harvests decrease evapotranspiration are examples of adjustments that can cause these changes.

Placing roads in floodplains near streams can confine streams, change the shape of the stream, increase the channel slope, and cause the stream to erode into its bed and banks. Recovery may take decades. Many streams are still adjusting to changes caused long ago. For example, changes in the elevation of a streambed may cause gully formation that continues to erode productive landscapes. Changes in riparian vegetation from strong, deep-rooted species (such as willow or alder) to weak, shallow-rooted species (such as Kentucky bluegrass), or loss of large woody materials can destabilize streambeds and banks. Recovery from stream channel alteration is possible. For example, a 12-year moratorium on sediment-producing activities on the South Fork Salmon River in Idaho resulted in a sizable improvement in channel condition (Chamberlin and others 1991).

Alternative 1 – No Action

Increased water runoff generated from timber harvest areas and road surfaces, and increased sedimentation from road construction, reconstruction, and maintenance would be highest under this alternative. Channel degradation from increased erosion or aggradation from increased sediment deposition is a function of each local situation. Channel degradation is most likely in upper watersheds having steeper slopes and more runoff energy, but it can also occur where slopes are more moderate. Sediment from these upper watersheds may be deposited in downstream channels with flatter slopes, such as in downstream water supply reservoirs or on lands managed by other entities. Due to the planned levels of roading and timber offer, Regions 10, 4, and 1, respectively, have the highest potential for stream channel adjustments. However, the roading planned for Region 2, and some local harvests in mountainous country in the East, hold similar concerns.

Alternative 2

The reduction in roading and timber offer provides a generally proportionate reduction in the likelihood of changes in stream channel morphology as outlined under Alternative 1. Opportunities to alter flow or sedimentation are reduced the most in Regions 10, 4,1, and 2, respectively, and in the other specific areas as mentioned above.

Alternative 3

While the reduction in roading is the same as under Alternative 2, the further reduction in timber offer, except for stewardship activities, under this alternative provides additional benefits in terms of conserving stream channel integrity closer to undisturbed conditions. Since Region 10 has little opportunity for stewardship harvest, both roading and harvest levels in that region would be at their minimum levels under this alternative.

Alternative 4

Elimination of timber offered for commodity and stewardship purposes, coupled with the roading reductions, provides the most benefits in terms of minimal likelihood of changes to stream channel morphology. Channels would remain closest to undisturbed conditions under this alternative. A slightly increased probability of large fires could cause changes to channel morphology on-site and downstream.

Soil Loss, Sedimentation, and Site Productivity

Affected Environment

Road construction, reconstruction, and maintenance may cause or accelerate surface erosion and initiate landslide events. General surface erosion caused by water washing over the soil produces mostly fine sediment (sand, silt, clay, gravels), while landslides produce sediment of all sizes including boulders and large organic materials (trees and root wads). Permanent and temporary road construction and reconstruction can cause increased risk of surface erosion and landslides, but this varies widely and depends on local site characteristics. The planned mileage of permanent and temporary road construction and reconstruction provides the best estimate of effects from erosion and sedimentation.

The greatest concern for soil loss and sedimentation lies in areas where land management activities, such as roading and timber harvest, occur in conjunction with high precipitation, steep slopes, soils prone to surface erosion, and terrain susceptible to landslides. NFS lands with these characteristics (illustrated in Figure 3) include:

- New England highlands of Vermont and New Hampshire,
- Central and Southern Appalachians,
- Central Rockies in Colorado,
- Coastal forests in California and Oregon,
- Sierra Nevada Mountains of California,
- Forests in the Cascade Range of Oregon and Washington,
- Central and northern Idaho and western Montana,
- High elevation portions of Nevada, Utah, and Wyoming, and
- Coastal areas on the Tongass National Forest in Alaska.

Land occupied by roads is essentially lost to long-term production of vegetation unless the road is allowed to revegetate. This is also true for skid roads, skid trails, and landings associated with a timber harvest unit. The amount of land occupied by these roads, trails, and landings varies due to terrain and logging systems used. Western skyline and helicopter logging uses about 2% of the sale area, while careful tractor skidding in the East uses from 4% to 5% (USDA Forest Service 2000h).

Regions 10, 4, 6, and 1 would offer the most timber for harvest in inventoried roadless areas. Region 10 plans to leave most new roads open (85%), while all other regions plan to close half or more of the new roads. Loss of productivity from accelerated erosion and compaction during timber harvest would affect these same regions, especially Regions 10 and 4.

Alternative 1 – No Action

Under this alternative, the planned offer of 1.1 BBF of timber and construction and reconstruction of 1,160 miles of road poses the greatest potential for soil loss, sedimentation, and lost soil productivity compared to the other alternatives. Regions 10, 4, 1, and 2 plan the most road construction and reconstruction. Region 10 plans to offer the most timber volume (49% of the national total) and roading (31% of the national total) in inventoried roadless areas. As in the discussion on water quality, the greatest risks occur during the largest precipitation and runoff events. These events may exceed the design standards of the road, timber harvest, and related best management practices.

Application of best management practices and timber-sale-contract requirements are generally effective in handling normal precipitation and runoff.

Alternative 2

The approximately 75% reduction in roading and associated 73% decrease in timber offer from inventoried roadless areas would proportionately decrease the risk of soil loss, sedimentation, and soil productivity compared to that under Alternative 1. The greatest benefits would occur in Regions 10, 4, 1, and 2, respectively, based largely on reduced road construction mileage.

Alternative 3

While the reduction in roading is the same as under Alternative 2, this alternative further reduces impacts by eliminating timber harvesting except for stewardship purposes. This would provide added benefits by reducing the likelihood of soil loss, sedimentation, and lowered site productivity.

Alternative 4

This alternative offers the least risk and the most benefit in terms of preventing soil loss, sedimentation, and soil productivity from timber harvest and road construction activities. The benefits are slightly increased over Alternative 3 based on the elimination of timber offered for commodity and stewardship purposes. However, additional potential exists for negative effects due to slightly increased risk of large fires that can cause substantial erosion, sedimentation, and landslides, both on-site and downstream.

Analysis Method Note: Figure 3 was created by overlaying the Roadless GIS database and ecosystems at the section level as described by Bailey (1995), then modified by knowledge of planned timber harvest and planned road construction activities. A map was developed overlaying NFS lands administrative boundaries and inventoried roadless areas. The product of this map was electronically overlain with a map of ecosystems at the section level, allowing one to see which national forests and grasslands were located in individual sections. The final step in the process was a comparison of planned timber offer and road construction and reconstruction data with the NFS lands/section map. Using the description of Bailey's sections with particular focus on high rainfall amounts or intensity, steep slopes, and unstable geology; NFS lands with high landslide risk, timber harvest greater than 5 mmbf between years 2000 - 2004, and more than five miles of planned road construction were highlighted as having an increased risk of soil loss and resultant sedimentation.

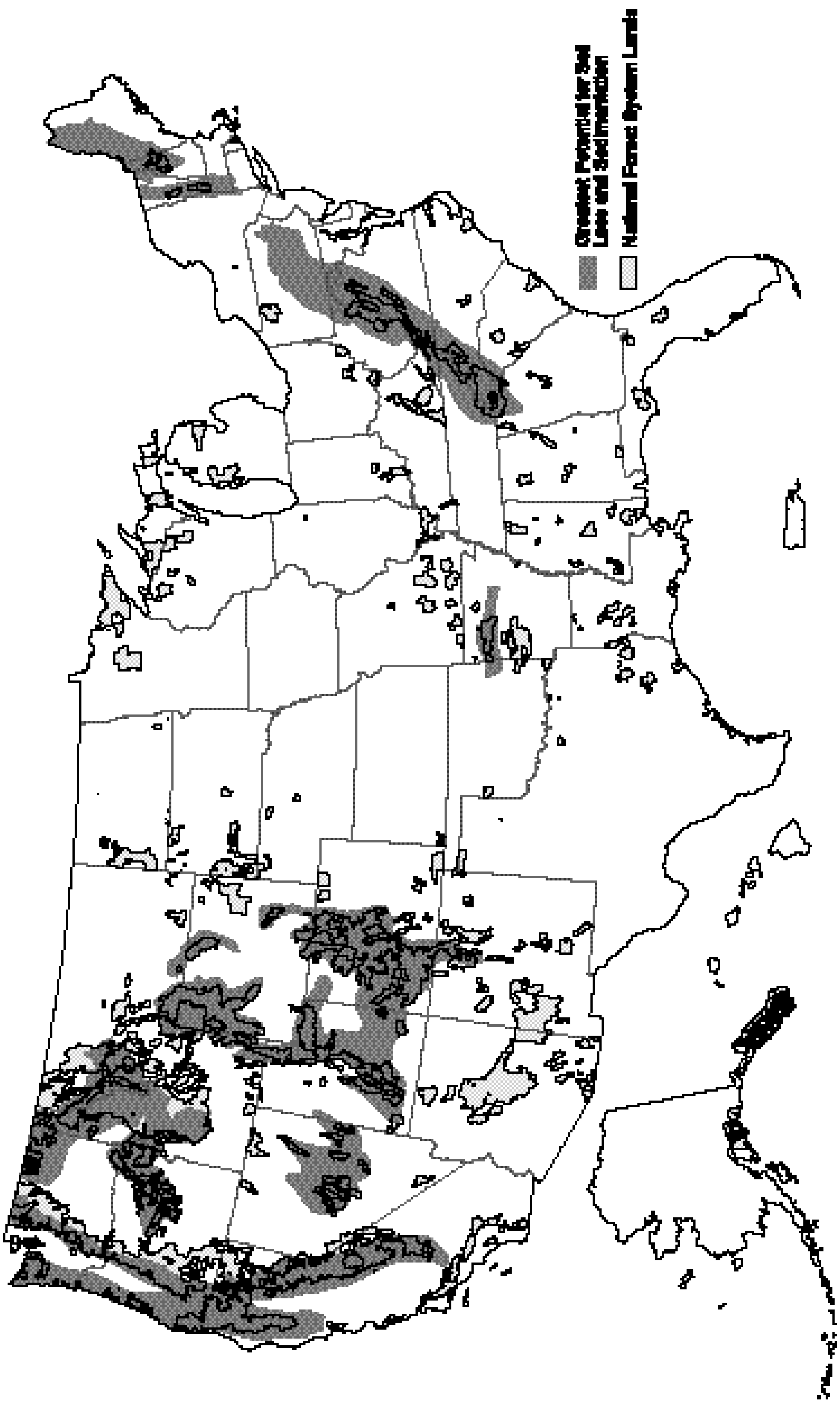

Figure 3. Areas with greatest soil loss and sedimentation potential. No data exist for Alaska, Hawaii, or Puerto Rico.

(Roadless Database 2000; Bailey 1995)

Landslides

Affected Environment

Landslides (the rapid downslope movement of soil, rock, water, and vegetation including mudflows, slumps, and debris flows) not only affect physical and biological watershed characteristics but can also threaten human life and safety. Landslides are recognized, particularly in many parts of Western forests, as a key source of sediment. Chamberlin and others (1991) stated that, "It is usually impossible to harvest unstable hillsides without increasing mass movements, however, except perhaps when careful selective logging with helicopter yarding can be done."

Even a high level of care cannot guarantee avoidance of landslides because loss of root strength will increase risk until roots from new vegetation can provide stability (Ziemer 1981; Robison and others 1999). Figure 4 highlights specific areas of concern where land-disturbing activities, such as road construction or timber harvest, have the potential to reactivate historic landslides or initiate new ones. While all regions have some areas of high landslide potential, certain locations deserve special attention. Land-disturbing activities are more likely to occur in the West than in the East, increasing the potential for landslide events. Table 1 lists the inventoried roadless acreage with high landslide susceptibility in some key States. In the West, areas of special concern include:

- Steep slopes in Southeast Alaska,
- Southwest corner and northeast and central mountains of Oregon,
- Portions of eastern Washington,
- Central and southeastern mountains of Idaho,
- Portions of the mountains of western Montana,
- Western edge and northwest corner of Wyoming,
- Central and northeast Utah,
- Large portions of central and western Colorado,
- Northern New Mexico, and
- North coastal, north central, and south coastal California.

While landslides are a natural process in these areas, extensive research and other investigations in the West indicate that land management activities, particularly roading and timber harvest, accelerate the incidence of landslides by several orders of magnitude (Swanston 1974; Anderson and others 1976; Swanston and Swanson 1976; Sidle and others 1985; Swanston 1991). Landslides were the principal source of erosion related to timber harvesting in some parts of the West, even though these slides occupy a small percentage of the land (Rice and Lewis 1991).

The winters of 1995 and 1996 offered unique opportunities to study landslides in the West. Severe storms in November of 1995 and February of 1996 triggered thousands of landslides throughout California, Oregon, Washington, Idaho, and Montana. A number of studies examined the relationship of land management activities to landslides. A joint study by the Forest Service and Bureau of Land Management in Oregon and Washington found that of 1,290 slides reviewed in 41 sub-watersheds, 52% were related to roads, 31% to timber harvest, and 17% in undisturbed forest (USDA Forest Service and USDI Bureau of Land Management 1996). An evaluation of landslides initiated by the Siuslaw National Forest found that roads were the source of 41% of the slides, harvest units less than 20 years old were the source of 36%, while natural forest accounted for the remaining 23% (USDA Forest Service 1997e).

The Pacific Rivers Council funded an aerial reconnaissance to evaluate landslides in Oregon and southern Washington in 1966. Of the 651 landslides in their inventory, 36% of the slides were related to roads, 71% to harvest units less than 15 years old, and 6% to natural forest conditions[a] (Weaver and Hagans 1996). The Oregon Department of Forestry did an intense ground survey of 506 landslides and found that most slides were located in existing forest stands and relatively few were caused by active or old roads, although slides from roads were larger than those in other settings (Robison and others 1999). Other studies on the Clearwater National Forest in Idaho (McClelland and others 1997) and the Mt. Hood National Forest in Oregon (DeRoo and others 1998) found that roads and timber harvest were major causes of landslides.

As an example of the variability in regional landslide susceptibility, two studies of landslide activity in basalt formations on the west side of the Payette National Forest following 1997 storms showed marked contrast to the much-studied landslide-prone granitic formations in the Idaho batholith on the east side of the same forest. An evaluation of 483 landslides by Dixon and Wasniewski (1998) revealed that 86% of the slides (mostly small) originated in areas unaffected by management activities, such as roading or timber management, although one third of the large slides were management related. They further found that only 15% were in forested areas, with the rest in grasslands and shrublands. Lesch and Shinn (1997) studied 31 landslides and found that none were directly related to management activities, such as roads, timber harvest, mining, or grazing, but originated in unmanaged settings.

a Percentages sum to more than 100% since some landslides are related to both roads and harvest units.

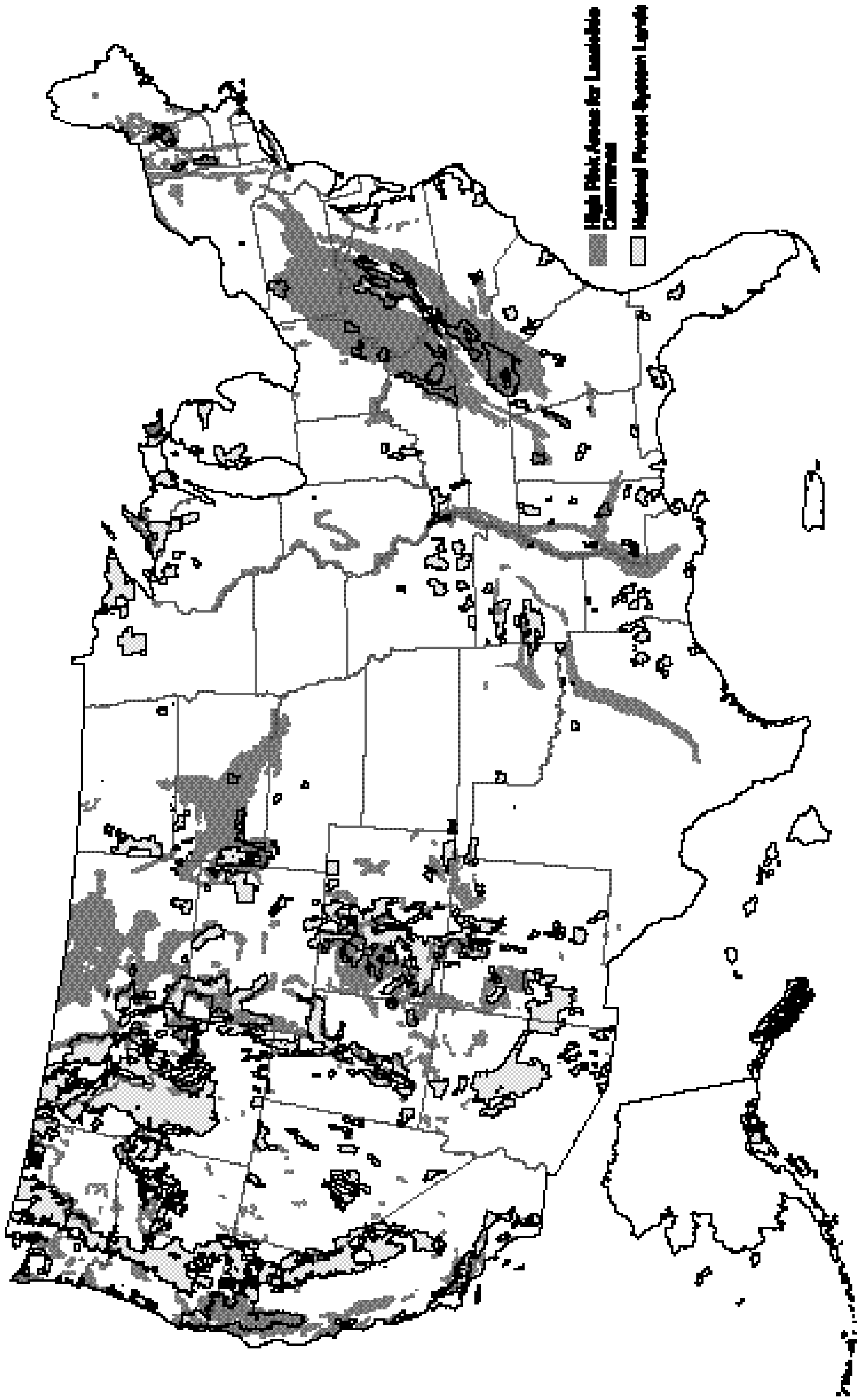

Figure 4. Generalized landslide susceptibility map for inventoried roadless areas. No data exist for Hawaii or Puerto Rico.

(Roadless Database 2000; Radbruch-Hall and others 1982)

Analysis Method Note: Figure 4 was created by overlaying the Roadless GIS database depicting inventoried roadless areas on NFS lands, a downloaded digital version of a map from the US Geological Survey professional paper by Radbruch-Hall and others (1982) for the lower 48 states, and a separate digital map for the Alaska Region produced by Regional Office GIS and soil specialists.

For the lower 48 states, the professional paper by Radbruch-Hall and others (1982) and the related map displayed six categories combining susceptibility and incidence of landslides. The analysis of alternative effects is most concerned with susceptibility to landslides so Figure 4 displays areas with high susceptibility of landslides. Incidence was not used since map data was a diverse mixture of historical and current data with wide variability of information available across the nation.

Similar information on landslide susceptibility from the US Geological Survey was not available for the Alaska Region. Discussions with Forest Service Regional Soil Scientist Terry Brock (Brock 2000) concluded that a surrogate for landslide susceptibility could be derived from terrestrial ecosystem survey data. Analysis of the data showed that percent slope was the most reliable indicator of landslide susceptibility, with slopes over 72%, posing a high susceptibility to landslides. Areas in the Alaska Region with slopes over 72% are displayed in Figure 4.

Table 1. States with more than 100,000 acres of inventoried roadless areas, with high landslide susceptibility.

State	Total inventoried roadless area acres (thousands)	Inventoried roadless area acres with high susceptibility (thousands)	Inventoried roadless areas with high susceptibility (%)
Alaska	14,779	1,595	11
Colorado	4,433	1,295	29
Montana	6,397	975	15
California	4,416	789	18
Wyoming	3,257	693	21
Utah	4,013	534	13
Virginia	394	316	80
Idaho	9,322	294	3
North Carolina	172	148	86
Oregon	1,965	143	7
New Hampshire	235	139	59
West Virginia	202	102	50

(Roadless Database 2000; Radbruch-Hall and others 1982)

Analysis Method Note: Table 1 displays only the acreages of inventoried roadless areas allocated to a prescription that allows road construction and reconstruction. It does not include inventoried roadless areas with prescriptions that preclude road construction and reconstruction, such as wilderness areas or other similar congressionally designated areas. The table also only lists States with more than 50,000 acres of landslide susceptible lands in these parts of inventoried roadless areas. Twelve other states have lesser acreages with these characteristics.

Reviewers of early drafts of this report expressed concern that Figure 4 Table 1 left an impression that overstated the risk of landslides in the eastern states. A series of telephone conversations between the author and key Forest Service personnel with years of local experience clarified the issue. Forest Hydrologist Joan Carlson on the White Mountain National Forest in New Hampshire (Carlson 2000), Forest Hydrologist Richard Burns on the National Forests in North Carolina (Burns 2000b), Forest Hydrologist Barry Edgerton on the Monongahela National Forest in West Virginia (Edgerton 2000), and Research Hydrologist James Kochenderfer in West Virginia (Kochenderfer 2000) all confirmed that while the geologic risk may be present due to slope, parent material, and other factors, actual occurrence of landslides was infrequent and related more to extreme climatic events than land use activities. While all four contacts had seen small local slumps related to road construction or similar activities, none of the events approached the magnitude common in the Western states.

Large or dramatic landslide events in the Eastern forests are rare but do occur (Patric 1976). In the Southern region, the Southern Appalachian Mountains have some areas of high susceptibility, particularly in eastern Tennessee, north Georgia, western North Carolina, and southwest Virginia. In the Eastern region, the mountains of eastern West Virginia and the mountains in central New Hampshire also have high landslide potential.

The likelihood of accelerating landslide incidence due to land management activities appears substantially different in the Eastern and Western parts of the country. Evaluations of Eastern landslides indicate that the cause is generally extreme precipitation events, such as hurricanes or intense summer convectional storms, where precipitation far exceeds the soil's capacity to absorb and transmit moisture. In the East, land use has less effect on landslide initiation than it does in the West (Anderson and others 1976; Eschner and Patric 1982; Neary and others 1986; USDA Forest Service 2000h; Kochenderfer 2000). Small, localized slumps and other landslide activities occur in the East and South, commonly because of improper road drainage (blocked or undersized culverts), which forces water onto unstable road-fill slopes (Burns 2000b; Carlson 2000; Edgerton 2000).

Alternative 1 – No Action

Of the four alternatives considered, Alternative 1 would have the greatest probability initiating landslides, with particular concern in Regions 10, 4, 1, and 2, respectively, and with local concerns in the coastal forests of Oregon, Washington, and northern California. While modern road construction and maintenance practices are much better than those used 10 to 30 years ago, special caution is warranted in areas with high landslide potential.

Alternative 2

The reduction in timber harvest and roading under this alternative would provide benefits through reduced probability of landslide events. Regions 10, 4, 1, and 2, respectively, would benefit most, with particular emphasis on Region 10 since that region has extensive landslide susceptibility yet plans the most timber harvesting and road construction and reconstruction.

Alternative 3

This alternative would share the same reductions in roading as Alternative 2, with small additional benefits from further reductions in timber harvesting and associated landslide susceptibility.

Alternative 4

The elimination of timber harvesting under this alternative would provide some incremental reduction of landslide potential compared to Alternative 3. Risk from roading is unchanged from Alternatives 2 and 3. However, the increased likelihood of uncharacteristic wildland fire effects as a result of the elimination of commodity and stewardship timber harvest increases the probability of landslides in highly susceptible areas.

Fire Effects on Watersheds and Burned Area Emergency Rehabilitation

Affected Environment

Fire Effects on Watersheds - Fire can have a wide array of effects on watersheds ranging from very subtle to extreme and dramatic. The degree of effect depends on a variety of factors including physical site (slope, aspect, elevation, soil type, soil moisture content, humus and litter type and depth), vegetation (type, density, canopy levels), fuel (live vs. dead volume, arrangement, moisture content), and weather (wind speed and direction, relative humidity, temperature). These factors also determine the intensity of the fire (the amount and rate of surface fuel consumption commonly reflected in flame length) and severity of the fire (a measure of the effects of the fire on ecosystem components such as water, soil, vegetation, habitat). Intensity is a good measure of fire behavior, but it is a poor measure of fire effects on watershed resources. For example, a very intense fire moving quickly over a site may burn the above-ground fuel. However, this type of fire may remove little of the soil litter and humus component in a scattered mosaic pattern. A less intense fire may burn for an extended period over a large area, removing virtually all above-ground fuel and litter and humus layers, exposing bare mineral soil and altering soil structural properties. Severity is the preferred measure to address the effects of fire on watershed resources.

While managers describe fires in two general categories (prescribed and wildland fire), the effects of fire on ecosystem resources is actually a continuum from very subtle effects to extreme effects. Some wildland fires can burn at low intensity and severity over large areas with few effects, while others burn at high intensity and severity with devastating effects. Some prescribed fires burn with few watershed effects, while others can cause serious disturbance over a portion of the burned area. In general, prescribed fires burn within carefully described conditions (fuel loads, fuel moisture, wind speed, fuel breaks or barriers), while wildland fires have no such constraints. Therefore, prescribed fires generally have fewer watershed effects, while wildland fires have greater impact.

Fire effects can generally be described in two categories: (1) on-site, and (2) downstream. Several authors have compiled excellent reviews of these effects (Tiedemann and others 1979; Wells and others 1979; Baker 1988; DeBano and others 1998). The following paragraphs highlight some of the known effects. The degree of these effects depends largely on the severity and extent of the fire at a watershed or multiple-watershed scale. Small fires with low severity will have few of these effects. Large fires over extensive areas may have many of these effects.

On-site effects:

- Precipitation interception – Fire consumes vegetation that usually intercepts rainfall, before it affects the ground and detaches soil particles, which results in surface erosion and eventual sedimentation.
- Transpiration – Fire can consume vegetation, reducing transpiration of water and make more water available for entry into soils or for runoff.
- Infiltration and overland flow – Fire burns the litter and humus layers of the soil, ash seals soil pores, chemical reactions make soils resistant to water entry (hydrophobic), which can result in water flowing across the soil rather than into it.
- Soil water storage – Water fails to enter the soil, reducing its capacity to store water for later use and increasing flow over the soil surface.
- Snowmelt and accumulation – Openings created by fire can increase snow accumulation on the surface and may increase the rate of spring melt.
- Surface erosion – Water running across exposed soil surface causes sheet, rill, and gully erosion.
- Landslides – In parts of the nation with high landslide risk, loss of ground cover and root strength can increase the number and size of landslides.

Downstream effects:

- Flow effects – Increased overland flow can increase flood flows in the elevation of the flood peak and in total volume of flow. Annual flow volumes may also increase if a large portion of a watershed is burned.
- Sediment – Sediment can be generated from surface erosion, and landslides can move great distances downstream, filling channels, floodplains, lakes, and wetlands, and damaging structures such as bridges, roads, and homes.

- Channel effects – Channels may fill with sediment, causing water to quickly overflow banks. Excess water may erode streambeds and banks or change channel shape.
- Chemical water quality – Fire can increase nutrients, such as nitrogen, in stream water, as well as phosphorous, potassium, calcium, magnesium, and other elements and chemicals.

Burned Area Emergency Rehabilitation - Severe impacts may occur on portions of watersheds that experience large wildland fires, activating a special program designed to handle these emergencies. The Burned Area Emergency Rehabilitation (BAER) program was developed in 1974 to assess severely burned areas and to implement treatments to prevent watershed emergencies (severe erosion, flooding, landslides, etc.) on the burned area and downstream. Teams of specially trained professionals evaluate fire effects, design and install treatments, and monitor the effectiveness of those treatments. Typical treatments include, but are not limited to, building sediment retention structures in stream channels, improving drainage on roads and trails, seeding to improve vegetative cover, mulching bare soils, placing burned trees or other materials on the slope contour to slow runoff and capture eroded soil, and similar measures (Robichaud and others 2000).

Burned areas are evaluated for treatment needs regardless of their location (Wilderness, inventoried roadless area, roaded areas, etc.). Decisions to treat areas are based upon predicted potential damages to life, property, and resources. The range of treatments may vary, however, depending on terrain or management restrictions (such as in Wilderness), or treatment costs may vary depending on accessibility or other factors.

The vast majority of BAER activities take place in Regions 1 through 6 although Regions 8 and 9 have used the BAER program on occasion. The level of BAER activities varies widely from year to year, depending on the severity of the fire season and the number of large and damaging fires that occur. BAER activity shifts between regions of the country. For example, the 1996 season saw considerable activity in the Southwest, intermountain West, and California. The 2000 fire season was very active in most regions except the Pacific Northwest. California commonly has busy fire years with substantial numbers of BAER projects.

The number of BAER projects and funding varies widely between years. A very active fire season occurred in 1996, with 58 projects at a cost of more than $10 million. In 1997, which was considered a modest year, there were 10 BAER projects that cost about $1.1 million. A relatively quiet year was in 1998, with only four projects at a cost totaling about $1.0 million. A significant increase occurred in 1999, with 18 projects totaling more than $6.7 million.

The 2000 fire year will be a record fire year and a record BAER year both in terms of projects initiated and total funds spent. As of September 16, 2000, the Forest Service approved 57 projects with more than 12 remaining to be submitted for approval. Total approved funding as of that date was more than $25 million. Projects have treated more than 200,000 severely burned acres. Treatments included seeding on 78,000 acres (this includes 14,000 acres of treatment to prevent the spread of nonnative invasive species), 4,000 acres of mulch, 11,000 acres of contour erosion barriers, 390 miles of road maintenance and culvert improvement, and 71 miles of trail maintenance (Copenhagen 2000).

Alternatives 1 through 3

Since the number of large wildland fires is expected to increase during the next 20 years, additional BAER activities would be required to assess conditions, design and install treatments, and monitor effectiveness. This expected rate of increase should slowly diminish as fuel treatments in priority areas become effective over larger landscapes. These alternatives would have no short- or long-term effect on the amount of BAER activity required by the Agency.

Alternative 4

Effects would be similar to those under Alternatives 1 through 3 except that the number of large fires is likely to continue to increase slightly after 20 years due to expected lower rates of fuel treatments. Increased BAER activity is expected as follow-up to these fires to protect water, soil, and air resources and life and property on-site and downstream.

Air Resources

Affected Environment

Air Quality – Good air quality is necessary to attain and sustain healthy and vital ecosystems. Clean air is an attribute that visitors to NFS lands highly value. People especially value viewing the scenery, being able to clearly see distant vistas, and knowing that these values are protected, even if they personally never experience them.

The authorities for air resource management on NFS lands include the National Forest Management Act, the Clean Air Act, and the Wilderness Act. A key focus of the Clean Air Act is on Class I areas. [a] There are 163 designated Class I areas for air quality protection in the nation. The Forest Service manages 88 of these areas, the National Park Service manages 49, the U.S. Fish and Wildlife Service manages 21, and American Indian Tribes manage five. All management activities on NFS lands must consider air quality related values for all Class I areas managed by any agency, not just those on NFS lands. Table 2 displays regions and forests with the highest likelihood of effects in Class I areas due to their proximity to inventoried roadless areas. Figure 5 displays Class I areas managed by the Forest Service, other agencies, and Tribes.

Congress required that the air pollution sensitive resources in these areas, especially visibility, be protected from degradation due to air pollution (Malm 2000). Congress established a national goal to prevent visibility impairment and improve visibility in all Class I areas. Regulations issued by EPA in 1999 specified that States must work closely with Federal land managers to establish strategies by 2004 to reduce to a natural level the regional haze that now affects virtually all Class I areas.

aNational Forest Wilderness Areas, National Parks, or National Wildlife Refuges greater than 5,000 acres in size, designated before establishment to the Clean Air Act Amendments of 1977. Class I areas can also include lands designated by Tribes or States. These areas serve as benchmarks for monitoring changes in air quality over adjacent lands.

Atmospheric emissions from road construction and use include particulate matter consisting of suspended fine (<2.5 microns in diameter) and larger coarse soils, nitrogen, and volatile organic compounds from gasoline engines, and soot from diesel engines. These pollutants contribute to visibility reduction. Nitrogen oxides form nitrates and ammonium deposits that contribute to soil and water acidification and leaching. Nitrogen oxides and certain volatile organics can react in the atmosphere to form ozone and other oxidants. At certain levels, ozone is phytotoxic and presents a human health risk. Oxidants are essential factors in the chemistry that creates acidification. Ozone, fine particles, and nitrogen dioxide are criteria pollutants and therefore, States must keep them at or below the critical levels established by the National Ambient Air Quality Standards.

Table 2. Inventoried roadless areas near Class I air quality areas.

Region	Forest or Grassland
Northern (1)	Flathead, Lewis & Clark, Lolo, Nez Perce, Clearwater, Little Missouri NG
Rocky Mountain (2)	All forests in Colorado, plus Bridger-Teton, Shoshone, Buffalo Gap NG
Southwestern (3)	Prescott, Tonto, Gila, Santa Fe
Intermountain (4)	Humbolt-Toiyabe, Dixie, Fishlake, Sawtooth
Pacific Southwest (5)	Six Rivers, Shasta-Trinity, Lassen, Mendocino, all forests in the Sierra-Nevada range, Los Padres, Angeles, Cleveland, San Bernardino
Pacific Northwest (6)	Mt. Baker-Snoqualmie, Gifford Pinchot, Siskiyou, Umpqua, Winema, Willamette, Deschutes
Southern (8)	Cherokee, Pisgah-Nantahala, George Washington-Jefferson
Eastern (9)	Monongahela, White Mountain
Alaska (10)	There are no Class I areas in proximity to inventoried roadless areas on the Chugach or Tongass National Forests.

(Roadless Database 2000)

Analysis Method Note: Table 2 displays the results of a multi-step process to assess the likelihood of activities planned in inventoried roadless areas impacting Class I areas managed by the Forest Service or other agencies. A map was produced combining Forest Service inventoried roadless areas and Class I areas. A visual inspection of the proximity of inventoried roadless areas to Class I areas led to the list of national forests and grasslands in Table 2. Impacts of particular concern that could effect Class I areas were smoke from prescribed fire and wildfire and dust and vehicle emissions from proposed road construction, reconstruction, and use.

In addition to protection of Class I areas, the Forest Service is required under Section 176 of the Clean Air Act to ensure that its actions will not cause or contribute to violations of the air quality standards or increase the frequency or severity of existing violations. Any inventoried roadless areas near non-attainment areas must need to consider impacts on those areas.

Mechanical or other fuel treatment before prescribed burning in areas with large fuel accumulations is an important aspect of meeting air quality standards. The direct removal of fuel reduces potential site emissions and indirectly reduces fuel consumption and hence, pollutants. Emissions generated during prescribed burning in untreated forests could exceed standards, a particularly critical concern in inventoried roadless areas adjacent to Class I areas or non-attainment areas.

Analysis Method Note: Figure 5 is a product of the digital overlay of Roadless GIS database maps of NFS lands and their inventoried roadless areas with maps of all Class I areas. Digital versions of the Class I area maps are available through the USDI National Park Service, Denver Service Center (USDI 1994). Information on non-attainment areas is available through the EPA web site on air resource data through their offices in Research Triangle Park, North Carolina (USEPA 1999c).

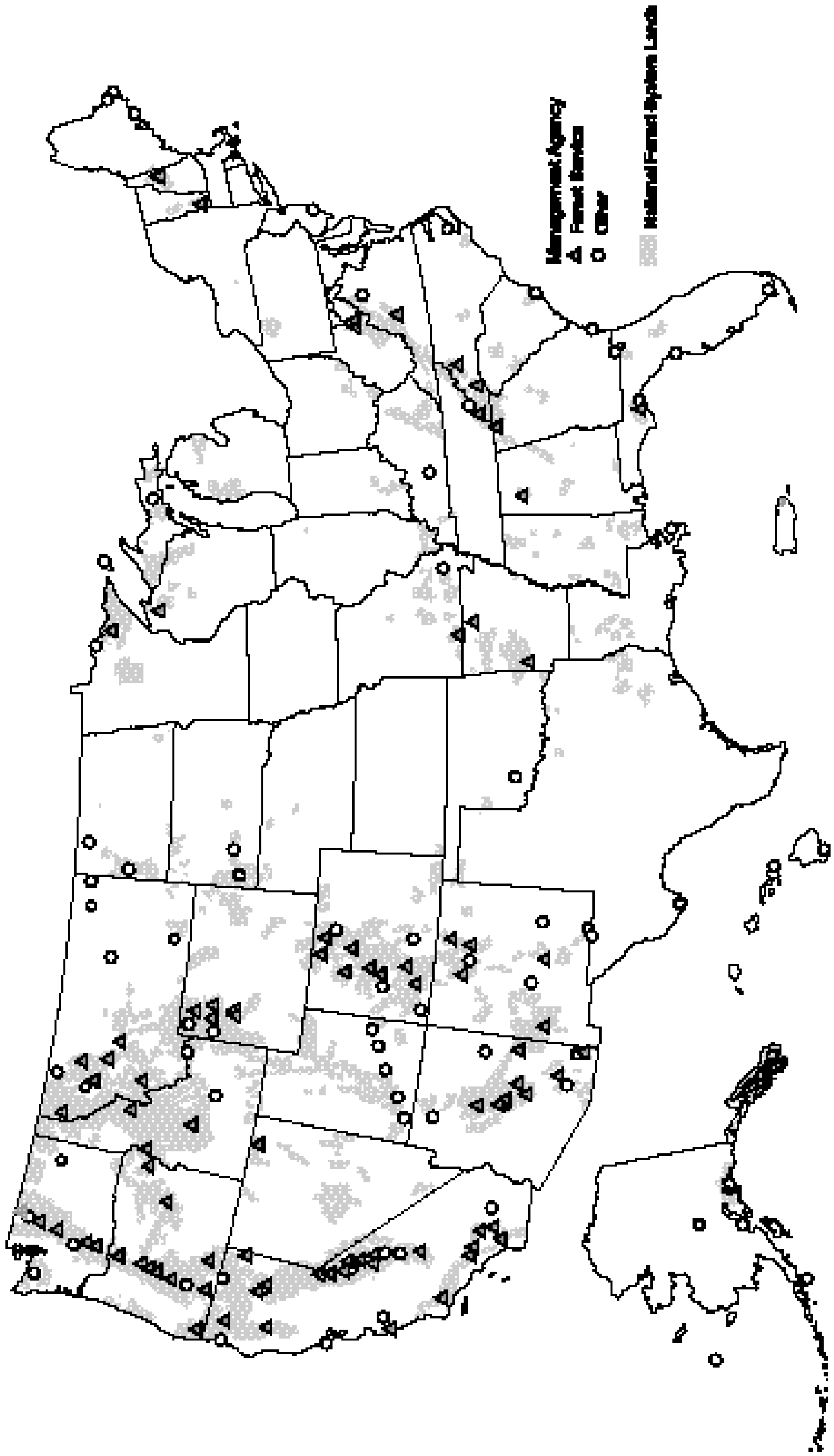

Figure 5. Class I air quality protection areas. No data exist for Alaska, Hawaii, or Puerto Rico.

(Roadless Database 2000; USDI, National Park Service 1994)

Global Climate Change/Carbon Sequestration - In responses submitted during the public comment period to the Draft Environmental Impact Statement (DEIS) on Roadless Area Conservation issued on May 10, 2000, many members of the public asked the Forest Service to disclose the effects of the alternatives on a host of topics related to atmospheric and air quality issues not fully addressed in that document. Commentors used many related terms such as global climate change, carbon sequestration, global warming, greenhouse gasses, desertification, etc. The following section briefly discusses these topics in general terms, relates them to the role of forests and forestry, discusses strategies to manage forests in light of global climate change/carbon sequestration (GCC/CS), discusses the role of NFS lands in the process, and estimates the effects of the various alternatives on GCC/CS.

Global Climate Change (GCC): Sommers (1996) reported "Climate change is defined as being both physical (e.g., global warming) and chemical (e.g., acid deposition and atmospheric CO_2 concentration)." According to Gates (1993), "The world has been warming for over 100 years and may warm in the future at a rate unprecedented in human existence, as a direct result of industry, forest destruction, and agriculture. These activities result in the accumulation of greenhouse gasses, including carbon dioxide, nitrous oxide, methane, ozone, chlorofluorocarbons, and others. These compounds, along with water vapor, are transparent to sunlight but absorb infared heat. Their presence in the atmosphere reduces the loss of heat from the earth's surface to outer space – the greenhouse effect - thereby making the world warmer."

While estimates vary among researchers, recent data shows increases in average temperatures of 0.6 ^{O}C. over the past 130 years with seven of the ten warmest years on record for the earth as a whole during the 1980s and 1990s (Gates 1993). Estimates for increases over the coming 100 years range from 3.6 to 6.5 ^{O}F. (Houghton and others 1996). Similarly, estimates of the effects of this change also vary between observers in the scientific, political, and media arenas. However, Seacrest and others (2000) report, "The consensus of the scientific community is that plausible scenarios of global climate change entail serious implications for humanity. Inundation of coastal areas, more frequent extremes of flood and drought, stresses on habitats and wild species, more urgent and violent competition for natural resources, agricultural failures, and new threats to human health are all conceivable consequences." Sommers (1996) reports, "…. resource management will become increasingly difficult. Forest fires and insect and disease outbreaks will become more common and more severe. Conflicts about water will become more strident."

Role of Carbon in GCC: "The energy that fuels human life and the world's economy is available because plants can combine water and carbon dioxide (CO_2) to convert solar energy to carbohydrates through photosynthesis" (Sommers 1996). A growing world population requiring food, shelter, energy and other necessities has resulted in accelerated use of fossil fuels (ancient plant life) and food, shelter, and energy (current plant life). Using these plants releases CO_2 into the atmosphere, and in conjunction with other elements and compounds, results in measured increases in temperatures at the global scale. While carbon is less effective than many other greenhouse gasses at trapping heat, the sheer volume of it in the atmosphere and the absolute rate of increase of carbon in the atmosphere makes it responsible for about 60% of the greenhouse action at the present time (Gates 1993). The main sources of carbon dioxide in the atmosphere include fossil fuel consumption and changes in land use, particularly deforestation in the tropics (Joyce and Birdsey In Press)

Carbon Sequestration (CS): Forest carbon sequestration is the net transfer of atmospheric CO_2 into materials that prevent its release back into the atmosphere either in the short term (a few years) to the long term (tens or hundreds of years). Carbon can be sequestered in plant materials, such as trees; in materials such as wood products; in landfills as waste materials, and commonly in the soil and the organic litter on the soil surface. The rate of buildup varies considerably by temperature, moisture, productivity of the site, and utilization of harvested biomass. Some areas are able to sequester large quantities of carbon for many years while others sequester very little or may lose some of the carbon stock as emissions (Birdsey 1996). Rising use of fossil fuels and plants for food, shelter, and energy have released huge quantities of carbon into the atmosphere, accelerating global warming. CS is a means to counter global warming through capture and long-term sequestration of carbon, delaying its return to the atmosphere. CS serves as an offset to the carbon added to the atmosphere through burning of fossil fuels, forest clearing for agriculture, and similar actions. Currently the rate of carbon emissions to the atmosphere far outstrips carbon sequestration and the size of the gap (mainly from use of fossil fuels) between gain and release grows wider each year. Management of forest vegetation can play a key role on both sides of this equation.

Role of Forests and Forestry: Forests cover between 35% and 40% of the earth's land area, account for about 65% of the carbon fixed annually, and store more than 80% of the world's organic carbon (Gates 1993). At the arrival of the first European explorers, the land that now comprises the United States had about 940 million acres of forest. Subsequent periods of clearing and regrowth since that time have left about 750 million acres of forest, with the remainder converted to other land uses (Sommers 1996). These forests cover about one-third of the United States, and between 490 and 500 million acres are classed as commercial timberlands.

In accounting for the location of carbon in forest ecosystems, studies indicate that 61% resides in the soil, 8% in the forest floor (litter and humus), 1% in the understory, and 29% in the trees. Of the carbon in trees, 50% is in the trunks (boles), 17% in roots, 3% in foliage, and the remaining 30% in other parts like branches, twigs, bark, etc. (Birdsey 1996, Birdsey and Heath 1997).

Forests in the United States currently serve as a significant carbon sink – absorbing more carbon than they release (Joyce and Birdsey in Press). Since about 1952, growth of forests in the United States has exceeded timber removals (through timber harvest), enough to offset 25% of U.S. emissions for the same period (Birdsey and Heath 1997). National forests have followed this pattern, particularly during the past 10 – 15 years, as harvest levels have declined from past levels, especially in the Pacific Northwest.

Role of U.S. Forests in the International Arena: In June 1992, representatives from 172 countries gathered at the Earth Summit in Rio de Janeiro to discuss environmental issues. The United Nations Framework Convention on Climate Change (FCCC) was adopted to achieve "…stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level would be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure food production is not threatened, and to enable economic development to proceed in a sustainable manner." The nonbinding goal of the Convention was "to return emissions of greenhouse gasses to their 1990 levels by the end of the decade." In October 1993 the United States responded with the U.S. Climate Change Action Plan (CCAP), a collection of nearly 50 individual programs covering emissions reductions, energy efficiency, and productivity enhancements including forestry activities (Clinton and Gore 1993).

As a followup to the FCCC, a series of Conference of Parties (COP) meetings were held. The third Conference of Parties (COP3), held in Kyoto, Japan, in December of 1997 produced an agreement known as the Kyoto Protocol. Under the agreement the United States is bound to reduce emissions of greenhouse gasses by 7% below 1990 levels in the 2008 to 2012 time frame. Participating countries raised concerns on how to comply with actions in the protocol. The FCCC asked the Intergovernmental Panel on Climate Change (IPCC) to develop a special report on the land use changes and forestry issues under discussion. Some of their recommendations addressed forestry activities in the United States. Four mitigation strategies and adaptive management strategies in the CCAP specifically address forestry actions. The first two actions are designed to increase carbon sinks. Interestingly, both are aimed at non-industrial private forests rather than Federal forests: (1) Reduce the depletion of nonindustrial private forests, and (2) Accelerate tree planting on nonindustrial private forests. The second two actions are designed to simultaneously increase carbon sinks and directly reduce emissions: (3) Accelerate source reduction, pollution prevention, and recycling, and (4) Expand cool communities programs in cities and Federal facilities. The third action has the most relevance on NFS lands.

<u>Mitigation Strategies</u>:

- Increase afforestation – stocking unstocked lands
- Improve forest management through increased net growth and more efficient forest harvest
- Expand use of wood for energy in place of fossil fuels
- Maintain carbon storage in forest soils
- Substitute wood for other products that require manufacture with fossil fuels or are more energy intensive than forest products
- Recycle wood and paper products to save energy

<u>Adaptive Management Strategies</u>:

- Diversify forest management to emphasize localized forest uses best adapted to that site and local conditions
- Manage for resilient forest ecosystems, recognizing that the principle adaptive opportunities involve forest ecosystem designs that are responsive to environmental stresses
- Emphasize high value natural ecosystems that are at high risk from climate change.

<u>Managing Forests to Maximize Carbon Accumulation (sink enhancement) and Minimize Carbon Loss (emission reduction):</u> A number of forest management methods are of particular interest in managing national forests and grasslands with some relevance to inventoried roadless areas.

- Increase the area of forest lands, particularly stocking currently unstocked lands
- Increase stocking levels of currently understocked lands
- Thin or perform other activities to increase growth rates of overstocked and stagnant stands (mechanical, fire, etc.)
- Reduce losses from wildfire, particularly severe, stand-replacing fires (Sampson and Clark 1996)

<u>Management of Harvest Levels and Rotation Length</u>: The literature contains considerable discussion concerning harvest levels and the amount of time a stand of trees is allowed to grow before final harvest (rotation length). Several general themes emerge from this discussion:

- To maintain carbon storage rates, letting existing stands grow while providing protection from losses is a reasonable strategy (Row 1996).
- 20% to 35% of the forest biomass ends up in long-term storage after harvest (wood products, landfills, etc.), while the remainder is released to the atmosphere. Reducing harvest level can cause a short-term increase in the amount of carbon stored in forests because releases of carbon to the atmosphere during removal of biomass and wood processing are avoided (Heath and Birdsey 1993, Heath and others 1996, Birdsey and others 2000).
- To increase carbon storage over the long term, a continuous cycle of harvest, efficient utilization of biomass, and regrowth of young, vigorous trees on highly productive lands can sequester more carbon than letting existing stands grow without harvesting (Row 1996).
- Conversely, removal of mature or old-growth stands to begin such cycles can produce the opposite effect; net carbon emissions will ensue for many decades following the initial stand harvest. Harvest of mature forests followed by reforestation does not appear to offer net carbon sequestration benefits (Shulze and others 2000)

Effects of Harvest Levels on NFS lands: Birdsey and others (2000) conclude that "Forestry activities that directly or indirectly result in emissions reductions may play an important role in the ability of the United States to meet its international commitments to reduce greenhouse gasses." While this may be true at the national scale, the delivery of forest products from NFS lands today is a relatively small part of the national totals. For example, NFS lands provided only 5% of the harvest across all ownerships in the nation in 1996. Projections show that national forests are planning to offer from 3 to 4 billion board feet of timber each year from 2000 to 2004. Of that total, planned timber offer from inventoried roadless areas is about 220 million board feet per year, between 5% and 7% of the projected total NFS offer, or about 0.3% of the planned annual national harvest from all ownerships. It is clear that the planned timber offer from inventoried roadless areas compared with the annual harvest in the United States is a small fraction.

Sizable reductions in timber harvest over the past 10 to 15 years from Federal lands, particularly lands managed by the USDA Forest Service, will likely result in more sequestered carbon on those lands for several future decades. This is especially notable in the Pacific Northwest, but also holds true for other regions. This increase in stored carbon will likely be offset, however, due to compensating increases in harvest on other lands, most notably private (industrial and nonindustrial) lands, primarily in the South, and increased harvest and imports, largely from Canada (USEPA 1995). Thus, on a global scale, the effect of the planned offer from inventoried roadless areas is insignificant.

None of the alternatives will have a measurable impact on global climate change, carbon sequestration, or related concerns for the following reasons:

- The planned annual harvest offer in inventoried roadless areas is 6% of the planned annual national forest timber offer; and
- The planned annual national forest timber offer is roughly 5% of the likely annual timber offered across the nation on all ownerships; therefore,
- The planned annual timber offer in inventoried roadless areas is approximately 0.3% of the likely annual timber offer for the nation; and
- Any planned reductions in harvest from inventoried roadless areas will likely be offset by increased imports or accelerated harvest from other forest ownerships.

Alternative 1 – No Action

Effects on air quality resources under Alternative 1 would be mixed. Emissions from road construction, reconstruction, and use would present a small but chronic air pollution impact, particularly where inventoried roadless areas are adjacent to Class I areas. Smoke particles are small and can travel great distances once airborne. Increasing access into inventoried roadless areas would likely facilitate additional prescribed burning to treat hazardous fuels and for other resource management purposes. Although smoke generated from these burns may affect Class I areas, the smoke events from prescribed burns are more predictable and manageable (compared to wildland fires) due to adherence to strict burning guidelines. The increased access may result in additional human-caused fires, particularly at the wildland-urban interface. In non-attainment areas, increased access and use may require mitigation measures.

Alternative 2

This alternative would prohibit roughly 75% of future roading and associated 73% decrease in timber offer in inventoried roadless areas, thus concentrating the expected increased public use on existing roads. This could increase vehicle emissions and dust along existing roads rather than dispersing them along the larger network of roads as under Alternative 1. Concentrating emissions on existing roads could increase impacts where these roads are in or near non-attainment areas. This alternative would eliminate most emissions from the new roads adjacent to Class I areas.

Alternative 3

Timber harvest and hazardous fuel treatments that could be accomplished without road access would still proceed under this alternative. Smoke from prescribed and wildland fire would likely be similar to that under Alternative 2. Impacts from road-generated emissions would be the same as under Alternative 2.

Alternative 4

There would be a slight increased risk of large wildland fires, particularly in the dry pine and fir types in the Intermountain West, and the large quantities of smoke they generate under this alternative. The effects from road emissions are the same as under Alternative 2.

Effects of Social and Economic Mitigation on Water, Soil, and Air Resources

These exceptions would increase the number of miles allowed to go forward from 293 to 358 (662 miles with the Tongass National Forest exemption) under Alternatives 2, 3, and 4. The effects of road construction associated with these exceptions would be similar to those previously described under Alternative 1. The beneficial effects related to prohibition on road construction under Alternatives 2, 3, and 4 would, therefore, be somewhat less than previously described.

It is impossible to predict the amount or location of road reconstruction that would be excepted for reasons of public health and safety. Realignment or upgrade of roads would likely result in additional ground disturbance, but it is unlikely that the environmental effects of such reconstruction would substantially expand the area affected beyond that of the original construction, especially given the current emphasis on environmentally sensitive design and use of BMPs. Such reconstruction could, however, result in changes in the kinds and amount of human uses in an area. Provided that conservation of other roadless characteristics is given strong emphasis in the project design and mitigation, this reconstruction would not be likely to result in additional substantial long-term ecological changes.

Estimates indicate that few miles of road construction would be excepted for Federal Aid Highway projects over the next 5 years in inventoried roadless areas. There is no reason to anticipate a substantial increase in the future. Only one 6-mile project is currently planned on the Chugach National Forest. While this project may have local effects on the characteristics and values associated with the affected inventoried roadless area, this limited level of activity would not result in a substantial change in the overall environmental effects of the alternatives.

Six national forests and grasslands in five regions have identified 59 miles of road tied to 21 projects during the 2000 through 2004 time frame related to the exploration or production of leasable mineral materials such as oil and gas, coal, phosphate, and geothermal energy. Regions most affected by this additional mileage are: Region 2 (38 miles) and Region 9 (12 miles). Environmental effects of these road miles, should they be built, are the same as effects for other roads in similar terrain. There is no certainty whether exploration activities conducted through access provided by these roads will eventually lead to development and production of mineral resources. If development does take place, effects on water, soil, and air resources can be substantial at the development site and around related facilities. Considerable literature exists addressing these effects (Nelson and others 1991; FISRWG 1998). However, these development activities are subject to stringent environmental analysis, mitigation, monitoring, and evaluation measures at the local level before, during, and after project implementation.

Potential near future geothermal development activity associated with inventoried roadless areas appears limited. Only one forest anticipated lease applications in the next 5 years, with three miles of associated temporary road construction. Although the magnitude of effects from geothermal exploration and development would be dependent on a variety of factors, impacts from such activities do not currently appear to pose substantial or widespread risks to water, soil, or air resources.

Oil and gas exploration and development activity within inventoried roadless areas is anticipated on four national forests in the next 5 years, with an estimated 34 miles of road construction for leasing and possible development. The demand for these resources is increasing nationally and may indicate additional interest in this kind of activity within inventoried roadless areas on these four forests and other NFS lands. The associated road systems would likely account for a substantial portion of potential environmental effects. Other effects of these activities would be determined by the location and size of areas disturbed, the duration of the activity, mitigation measures used for environmental protection including containment of toxic materials used in the drilling process, the type and effectiveness of site reclamation, and the overall level of exploration and development activity within an area.

One national forest identified 17 miles of roads associated with five coal exploration and leasing projects with possible eventual development of underground mining operations. Another national forest identified 5 miles of road with five phosphate leasing and permitting activities with potential for surface mining activities. The coal developments are anticipated to be subsurface and therefore, the environmental impact would involve few disruptions to surface resources and inventoried roadless values except as associated with roads. However, subsurface mining can disrupt surface water quality through release of acid waters from openings and runoff from tailing piles. The proposed expansion of phosphate mining is an open pit operation and therefore, poses higher risks to water quantity and drinking water source areas, channel morphology, soil loss, sedimentation, and soil productivity.

Environmentally, application of the social and economic mitigation measures to the prohibition alternatives would diminish the potential beneficial effects of a prohibition on road construction and reconstruction, given the greater amount of area disturbed and the kinds of activities enabled. Depending on a variety of factors, leasable mining activities supported by road access would potentially have detrimental effects to water, soil, and air resources. However, at current levels of activity and given the application of best management practices, the potential extent of these activities and their impacts do not appear to be widespread, and it is unlikely that most effects would extend much beyond local levels. Decisions on whether to permit such activities, and if so, what environmental mitigation measures would be required, would be made using current planning and decision-making processes. Overall, even with application of these measures, Alternatives 2, 3, and 4 would still provide important benefits relative to water, soil, and air resources.

Other Indirect and Cumulative Effects on Water, Soil, and Air Resources

Introduction: The following discussion evaluates the cumulative effects of the prohibition alternatives on water, soil, and air resources as described by the seven measures highlighted below. This analysis discusses past, present, and reasonably foreseeable actions and their effects of the four prohibition alternatives.

Measures: The environmental analysis for water, soil, and air resources uses seven measures to assess the effects of the alternatives: (1) Water quantity and timing, (2) Water quality and drinking water source areas, (3) Channel morphology, (4) Soil loss, sedimentation, and site productivity, (5) Landslides, (6) Fire effects on watersheds and Burned Area Emergency Rehabilitation, and (7) Air resources.

Drivers: There are two levels of factors that "drive" the analysis of effects on the measures.

Primary Driver:

- Population: The population of the United States is projected to climb from 286 million in the year 2000 to 400 million in the year 2040

Secondary Drivers:

- Road construction and reconstruction: miles
- Timber offer volume: million board feet
- Large wildfires: number per year
- Recreation use: developed and dispersed
- Minerals, oil & gas: exploration and development

Spatial Scales: This cumulative effects analysis looks primarily at administrative scales but also discusses these in context of watershed scales since most effects on measures (except air resources) are assessed on a watershed basis.

Administrative Scales: The analysis looks at three main levels of scale: (1) Inventoried roadless areas, (2) National Forests and Grasslands, and (3) Nationally (Note: Air resources are also viewed in a global scale)

Watershed Scales: These scales view the effects of actions on the measures in terms of hydrologic units as defined by the United States Geologic Survey (USGS). The USGS divides the nation into four progressively smaller subdivisions of watersheds. The nation is divided into 21 major regions (1st level). These regions are further subdivided into 222 subregions (2nd level), then into 352 accounting units (3rd level, now called basins), and finally into over 2000 cataloging units (4th level, now called subbasins). For administrative purposes, the Forest Service further subdivides these subbasins into watersheds (5th level), and further into subwatersheds (6th level). These various levels of subdivisions are referred to as "hydrologic units" and numerical codes are use to describe these divisions, called "hydrologic unit codes" or "HUCs". Each successive level is identified using a 2-digit code. A 1st level HUC (region) will have two digits while a 5th level HUC (watershed) will have ten digits.

Using the Pacific Northwest as an example, the Pacific Northwest Region covers most of Oregon, Washington, Idaho, and western Montana (HUC 17). One subdivision of this region is the Lower Snake River Subregion, which occupies 35,200 square miles of eastern Oregon and Washington and western Idaho (HUC 1706). A further division of the Lower Snake River is the Salmon River Basin, covering 14,000 square miles of Idaho (HUC 170602). The Salmon River is then subdivided into subbasins, one of which is the 1310 square mile South Fork Salmon River (HUC 17060208). The Payette National Forest further divides this into administrative watersheds, such as the 131 square mile East Fork of the South Fork Salmon River (HUC 1706020804).

The direct and indirect effects of management actions on the measures are detected at different spatial scales. Some are detected most easily within the bounds of the inventoried roadless area, which are generally at the 6th and 5th level HUCs. Other effects will continue off the inventoried roadless area into the general forest area or even off the forest to other ownerships at the 4th level HUC. It is highly unlikely any effects will be detectable at 3rd level or larger HUCs.

Many inventoried roadless areas are either in the headwaters of stream systems or are immediately downslope of relatively undisturbed areas such as Wilderness. This is particularly true in the West. In these geographic positions, inventoried roadless areas have special value because they produce high quality water on that site or deliver that water for downstream users. Even though other uses within the watershed and other ownerships downstream may degrade the quality of water once it leaves the inventoried roadless area, it may have particular value on-site, such as habitat for fish, a source of clean water for irrigation, or a key recreational resource. Where inventoried roadless areas may be surrounded by roaded areas, a more typical situation in many parts of the East, the healthy landscapes provided by inventoried roadless areas may provide an oasis within otherwise heavily used watersheds.

Unlike water and soil resources, air resources are not confined to watershed boundaries. Activities that effect air resources can travel to the area of concern from long distances, either from within the national forest or grassland, or from many miles outside the area. Pollutants such as dust or smoke generated within an inventoried roadless area may travel scores or hundreds of miles outside the local area depending on wind speed, direction, and other parameters. Equally important is the impact of pollutants (smoke, dust, chemicals, etc.) generated outside of inventoried roadless areas that reduce air, water, and soil quality within the area. Air quality on Forest Service lands may be compromised to the point that needed land treatments, like prescribed fire, can not be undertaken.

Time Scale: Three specific time frames are used for this analysis. The 5-year time frame (2000-2004) depicts present and short-term future action and effects. The 20-year (2020) and 40-year (2040) time frames depict the reasonable foreseeable future of actions proposed in the alternatives.

Effects of Drivers on Measures: Past and Present Actions: At the 4th level and larger watersheds, which includes both National Forest and many other land ownerships, a wide variety of land uses over many decades have dramatically altered natural processes in most watersheds in terms of water, soil, and air resources. Growing populations and the related desire for goods and services has fueled the following activities:

- Construction, maintenance and use of transportation facilities have occurred across the nation. These include private, local, county, state, and federal highways, as well as airports, rail lines, and other infrastructure.
- Traditional agricultural activity such as grazing of domestic livestock and row cropping, as well as rapidly expanding enterprises such as large-scale poultry and confined animal feeding operations such as feedlots.
- Timber management, fueled largely by increased demand for housing and paper products
- Construction and operation of hydrologic modifications such as dams and levees (nationwide) and water withdrawals for irrigation and other uses (largely in the West)
- Industrial expansion, primarily in the East, but also accelerating in a some western locations such as Denver, Salt Lake City, Phoenix, Boise, and Albuquerque.
- Elimination or reduction of natural fire cycles (most dramatic in the West)
- Widespread development of oil, gas, coal, and mineral resources have impacted watersheds across the nation.
- Recreation activities, both developed and dispersed, have expanded across the nation on many land ownerships. Many are directly related to water resources.
- Urbanization and sub-urbanization across the nation.

Affects of Reasonably Foreseeable Future Actions on Measures by Alternative:

Trends in key activities that Affect Water, Soil, and Air Resources:

Transportation: FS roads program will focus on: (1) shifting emphasis from building new roads to reconstructing needed existing roads, (2) maintaining existing needed roads to proper standards, and (3) decommissioning unneeded roads. Total mileage will drop to between 260,000 and 300,000 miles, depending upon funding, over next 20 – 40 years. Transportation facilities outside FS lands, but within 4th level watersheds, will continue to expand for urban, suburban, rural, industrial, resource management, recreational, and similar uses.

Timber harvest: Increasing population will drive growing markets for wood products. The FS will continue to offer between 3 and 4 billion Bd. Ft. for sale annually over the next 40 years. This translates into a decreasing share of the U.S. and world market over time. Harvest on non-FS lands within the 4th level watersheds, particularly in the Southeast, will likely increase to offset relatively low FS offer volumes. Imports from Canada and other nations will likely continue to rise to meet demand.

Fire: The average annual number of fires will likely remain constant but some increase in the percentage of large, damaging wildfires is expected. Suppression success will likely keep 98 percent of wildfires small with little damage, but fires that escape are more likely to grow in size and severity, requiring a larger effort to rehabilitate those burned areas. Fires on non-FS lands, both public and private, will likely have the same trends as those on FS lands.

Recreation: Demand for developed and dispersed recreation opportunities on all lands will continue to increase. Larger numbers of people, increasing age of the population, shifts in ethnic mixes, and other demographic changes will alter demands on FS lands. The FS will continue to provide dispersed recreation opportunities that non-public lands cannot provide. However, the demand for motorized and developed facilities will continue on FS lands as well.

Minerals, Oil & Gas: Rising populations will continue to drive expanded demand for all kinds of minerals and oil and gas from all lands. Requests for exploration on FS lands will continue as will extraction of known materials. Exploration and development of similar resources off FS lands will likely increase as well to meet demand.

Land Use: Land outside FS boundaries will experience accelerated use for additional housing, schools and similar infrastructure, business and industry, transportation facilities, etc. These uses will increase the likelihood of impacts on water, soil, and air resources at all watershed levels. Home construction at the wildland-urban interface will continue, even at the 5^{th} and 6^{th} level watersheds on inholding properties, and particularly along watercourses and similar desirable locations. Road access to those residences, particularly those located in and adjacent to riparian areas and floodplains, can directly impact streams through increased sedimentation, loss of shade, stream crossings, and hardening of runoff surfaces.

Measure 1 - Water Quantity and Timing:

Past and Present Actions:

The multitude of land uses discussed above on non-NFS lands have modified natural flow regimes by generally increasing average annual water yields and altered natural flood levels, timing, and frequency. Where significant land clearing or hardening of surfaces has occurred, peak flows or rapid delivery of water may have destabilized channels and caused bank erosion and localized flooding. Clearing of forests for non-forestry uses such as expansion of housing, industry, and transportation are trending upward in most parts of the nation.

There has been comparatively little activity in inventoried roadless areas to change water flow or timing from natural levels. Considerable activity on forest lands outside of inventoried roadless areas has altered land surface and cover enough to modify natural levels of flow and timing.

Future actions:

Alternative 1. Incremental changes in flow timing and flood flows would be most likely in and possibly downstream from inventoried roadless areas in the arid and semi-arid portions of Regions 1 and 4. Changes in average annual water yield would be most likely within inventoried roadless areas and downstream on other forest lands in high precipitation zones in Regions 5, 6, and 10. No incremental measurable changes would be expected beyond the forest due to the compounding effects of flow from other land uses.

Alternative 2. Decreased levels of timber harvest and road construction and reconstruction would reduce the number of opportunities to detect changes in average annual flows, flood flows, or flow timing. For the harvesting and roading that does occur, effects would be similar to those in Alternative 1.

Alternative 3. Cumulative effects would be similar to those in Alternative 2 but with fewer opportunities for these effects to occur since timber would be offered for sale only for stewardship purposes.

Alternative 4. Few incremental cumulative effects would be likely except for the slight probability of increased volume and flood flows from areas burned by large wildfires.

Measure 2 - Water Quality and Drinking Water Source Areas:

Past and Present Actions:

The large variety and number of land use activities such as agriculture, residential and industrial construction, timber harvesting, transportation construction have increased overall sediment, nutrients, and temperature loadings above natural levels to most water bodies downstream of national forest boundaries. Most contributions of pollution from forestry are in the form of sediment with some concerns for nutrients and temperature. Agriculture, urban development, and other industrial uses contribute sediment and nutrients but also other pollutants such as heavy metals, pesticides, and oils and grease. Where these pollutants are upstream of national forests and grasslands, a situation more common in Regions 8 and 9, degraded waters may lower the quality of water on the Forest Service lands. In the more common situation where Forest Service lands occupy headwaters locations, high quality water leaving Forest Service lands flows through other ownerships where activities may add pollutants and degrade water quality for an array of beneficial uses, including human consumption, recreation, and habitat for aquatic species. On forest lands outside of inventoried roadless areas, change in water quality parameters can be attributed to a wide array of multiple use activities. Within inventoried roadless areas, various forms of recreation, livestock grazing, and fire and other activities continue and may reduce water quality.

Future Actions:

Alternative 1. Incremental changes in water quality would most likely be detected within inventoried roadless areas and possibly downstream into other lands within the forest but should not be detectible off the forest due to the interaction of pollutants coming from other ownerships and land uses. Regions 10, 4, and 1 would be most likely to experience any water quality effects, largely from timber harvest levels and associated road construction and reconstruction. The probability of effecting drinking water source areas would be dependent on the proximity of the individual land-disturbing activity to the withdrawal point for the water supply.

Alternative 2. Due to the decreased roading and related timber harvesting, fewer opportunities would exist to alter water quality in inventoried roadless areas or on forest lands outside these areas. Where these activities would occur, incremental changes in water quality or impacts on drinking water source areas would likely not be detectible below the forest boundary.

Alternative 3. Cumulative effects would be similar to those in Alternative 2 but with fewer opportunities to impact water quality since timber would be offered for sale for stewardship purposes.

Alternative 4. Few incremental cumulative effects would be likely except where the slight probability of increased large wildfires result in additional soil loss and nutrient mobilization, both within inventoried roadless areas and downstream on and off the forest.

Measure 3 - Channel Morphology:

Past and Present Actions:

Past land uses off national forests and rangelands have combined to alter channel shape through changes in sediment loads, water yields, and flood flows and frequencies. In many areas these effects have destabilized streambeds and channels, resulting in a shift from dynamic equilibrium to unstable channels undergoing readjustment to new sediment and water volumes. This effect is particularly pronounced where large areas have been cleared or hardened for urban development, agriculture, or transportation systems, or flow levels modified via irrigation withdrawals or trans-basin diversions. Few streams beyond forest boundaries are truly unaltered from their natural conditions. These changes are less pronounced on the national forests, particularly in inventoried roadless areas that have seen limited ground-disturbing activity.

Future Actions:

Alternative 1. Incremental changes in channel morphology would be most likely where activities occur in inventoried roadless areas and possibly on adjacent national forest lands. Increased road crossings and sediment additions from road construction and re-routing drainage along roads would present the highest concern, particularly in Regions 10, 4, 2, and 1 since they project the most road activity. Incremental changes in channel morphology off national forests would be unlikely.

Alternative 2. Reduced levels of roading and related timber harvest would decrease the opportunity for activities in inventoried roadless areas to alter stream morphology.

Where these activities would occur the effects would be similar to those under Alternative 1.

Alternative 3. Cumulative effects would be similar to those under Alternative 2 but with fewer opportunities for these effects to occur since timber would only be offered for stewardship purposes.

Alternative 4. Few incremental cumulative effects would be likely except where the slight possibility of increased large fires could increase erosion and sediments that could move from inventoried roadless areas downstream to other national forest lands and beyond.

Measure 4 - Soil Loss, Sedimentation, and Site Productivity:

Past and Present Actions:

Past ground-disturbing land uses across the US have resulted in soil losses, reduced site productivity and delivery of sediment to stream systems. On lands outside national forests and grasslands, urban and suburban development, agriculture, expanding transportation infrastructure, silvicultural operations and other land uses are the most common source of these impacts. On NFS lands, past uses have caused some of the same effects as those at the larger scale although the effects of urbanization and industrial uses are limited.

Current land uses in watersheds beyond the national forest level continue to cause some soil loss, sedimentation, and reductions in soil productivity. Increasing urban sprawl, expanding transportation networks, and similar uses are entering into formerly rural landscapes. On national forests and grasslands, traditional roading and timber harvest have declined considerably while disturbances from other uses such as OHV activity are increasing.

Future Actions:

Alternative 1. Losses of soil and site productivity would be most likely at the individual inventoried roadless area level but seldom beyond. Some sediment increases generated from activities in inventoried roadless areas may remain detectible at the national forest level but would rarely be detectible beyond the forest due to additions from other land ownerships and land uses. Regions 10, 4, 2, and 1 would be the most likely to experience localized sediment increases, due largely to planned road activity.

Alternative 2. Incrementally increased surface erosion and decreases in soil productivity would be likely only at the project level within inventoried roadless areas but not beyond. Sediments generated from erosion may travel onto national forest lands but would likely not be detectible past forest boundaries.

Alternative 3. Cumulative effects would be similar to those in alternative 2 but with fewer opportunities to occur as a result of further reduced timber harvesting.

Alternative 4. Few incremental cumulative effects would be likely beyond inventoried roadless areas except for the additional slight probability of effects both on site and downstream from additional large fires.

Measure 5 - Landsides:

Past and Present Actions:

Landslides have been major sources of sedimentation at all watershed scales in many locations in the western US and a few rare occasions in the East. Past road construction from forestry operations, timber harvesting and urban development have triggered landslides in steeper terrain, particularly in high landslide risk areas such as the Idaho batholith, the Sierra Nevada, and southeast Alaska. These past occurrences provide a continuous supply of sediment to stream systems, often causing channel aggradation, flooding, eroded stream banks, and loss of habitat complexity in streams. Roads constructed across step terrain for urban development and major highways also caused increased landslide, mudflows, debris avalanches and other hazards to human life, property and aquatic resources. Large and damaging wildfires have also reactivated or initiated landslides in some areas of the West, such as in central Idaho and northern California.

Some urban development, highway, and road construction on non-Forest Service lands still fail to recognize landslide hazards and deal with them properly. At the national forest and grassland level, reduced timber harvests and road construction, coupled with BMPs and more modern design criteria, have reduced landslide incidence substantially. Many current landslide problems continue to occur in relation to roads and activities implemented before new designs became widespread. The decommissioning of many unneeded roads has helped reduce the incidence of landslides along old roads but the lack of maintenance funding in general has allowed many existing roads to increase vulnerability to landslides. Many remaining inventoried roadless areas are in areas of high landslide susceptibility where successful implementation of BMPs will prove challenging under even ideal circumstances.

Future Actions:

Alternative 1. Within inventoried roadless areas, landslide activity would be most likely to increase in high-risk geologic formations in Regions 1, 2, 4, and 10. Some landslide debris may be detectible downstream on the national forest but would not likely to be detectible beyond these lands.

Alternative 2. Significant reductions in roading and related timber harvest would reduce the opportunities for landslide-related impacts to occur. Where they occur, effects would be similar to those described under Alternative 1.

Alternative 3. Decreases in timber harvesting opportunities would further reduce the probability of landslides causing incremental effects off NFS lands.

Alternative 4. Some slight opportunity would exist for increases in large fire activity in inventoried roadless areas, with possible increases in landslides. Debris from these slides would impact inventoried roadless areas and may be detectible on national forests but would likely not be detectible beyond that level.

Measure 6 - Fire Effects and Emergency Burned Area Rehabilitation:

Past and Present Actions:

Large and damaging wildfires have had significant effects on water, soil, and air resources for many years and at all scales. Effects may be detectible many miles downstream from large fires. A sizable and growing program designed to rehabilitate severely burned areas has had some success in preventing extensive downstream damages from these events but much remains to be learned to increase success to protect lives and property.

Future Actions:

Alternatives 1, 2, and 3. No increased incidence of fire activity in general or large fires in particular would be expected. No increases in on-site or downstream effects would be expected.

Alternative 4. A slightly elevated probability of large fires in inventoried roadless areas would increase the likelihood of effects in inventoried roadless areas, on adjacent national forests, and possibly onto lands immediately downstream from national forests.

Measure 7 - Air Resources:

Past and Present Actions:

Unlike water and soil resources, effects on air resources reach beyond watersheds, having multi-state impacts. Until passage of the Clean air Act, air quality in many parts of the nation, from urban to rural areas, was in decline. Smoke and other particulates, exhaust emissions from vehicles, industrial pollution, and other sources were causing notable damages. Emissions from sites off national forest lands caused measurable damage to critical resources on national forests and grasslands. Pollutants originating on Forest Service lands, such as smoke from wild or prescribed fires, were reducing air quality on other lands.

Implementation of current management guidelines to protect air quality have made progress, with particular focus on Class I areas. Limits on prescribed burning are making progress in managing smoke from these fires but concern exists about how these guidelines will affect our ability to implement increased acreages of prescribed fire for fuels and other treatments. Predictions of increased numbers of large wildfires on multiple ownerships in the West raise concerns about the likelihood of increased smoke from those incidents.

The role of the US as a nation in accelerating global climate change is under intense debate. Our high use of fossil fuels at the national scale, combined with and other activities that produce greenhouse gasses, is of considerable concern. Little evidence exists, however, to implicate management of NFS lands as a major contributor to this problem either nationally or globally.
Future Actions:

Alternative 1. Impacts on air quality from road construction and use and timber sale activity would be detectable only at the local level. Poor air quality entering Class I areas from non-national forests lands would make identification of sources difficult. Incremental additions to global climate change and carbon sequestration would not be detectable.

Alternative 2. Substantial reductions in roading and related timber harvest would result in few, if any, incremental changes to air quality beyond the local level. Emissions from outside sources would make it difficult to detect impacts from the activities in inventoried roadless areas. Incremental additions to global climate change and carbon sequestration would not be detectable.

Alternative 3. Further reduction in timber harvest levels decrease the likelihood of activities in inventoried roadless areas producing detectible impacts to air quality either in inventoried roadless areas, on the surrounding national forest, or off the forest. Incremental additions to global climate change and carbon sequestration would not be detectable.

Alternative 4. The slightly increased likelihood of large fires would elevate the probability of smoke from wildfires impacting air resources on-site in inventoried roadless areas as well as on the surrounding forest and non-national forest lands. Incremental additions to global climate change and carbon sequestration would not be detectable.

Glossary

Afforestation – The establishment of a forest or stand in an area where the preceding vegetation or land use was not forest

Basal area – The cross-sectional area of all stems of a species or all stems in a stand measured at breast height (4.5 ft. or 1.37 m. above the ground) and expressed per unit area of land (e.g., 25 sq. ft. per acre).

Best management practices (BMPs) – A practice or usually a combination of practices that are determined by a State or a designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling point and nonpoint source pollutants at levels compatible with environmental quality goals.

Class I air quality areas – National Forest System Wilderness areas, national parks, or national wildlife refuges greater than 5,000 acres in size, designated prior to the establishment of the Clean Air Act Amendments of 1977. Class I areas can also include lands designated by tribes or States. These areas serve as benchmarks for monitoring changes in air quality over adjacent lands.

Criteria air pollutants – A group of common air pollutants (such as carbon monoxide, particulate matter, or ozone) regulated by the Environmental Protection Agency (EPA) on the basis of criteria (information on health and/or environmental effects of pollution). Criteria air pollutants are widely distributed across the country.

Decommissioning – Demolition, dismantling, removal, obliteration, or disposal of a deteriorated or otherwise unneeded asset or component, including necessary cleanup work. This action eliminates the deferred maintenance needs for the fixed asset. Portions of an asset or component may remain if they do not cause problems or require maintenance.

Domestic water sources – Watersheds containing National Forest System lands that provide surface waters to facilities that treat and distribute water for domestic purposes. These purposes include normal household uses such as drinking, food preparation, bathing, washing clothes and dishes, watering lawns and gardens, and similar uses.

Dynamic equilibrium – A natural state of stream stability when channel features persist over time within a range of conditions. Dynamic equilibrium uses a series of self-correcting mechanisms that allow the ecosystem to control external stresses or disturbances, thereby maintaining a self-sustaining condition. For example, a stream is able to consistently transport its sediment load, both in size and type, associated with local deposition and scour.

Fire intensity – The rate at which fuel is consumed and heat is generated.

Fire severity – Denotes the scale at which vegetation and a site are altered or disrupted by fire, from low to high. It is a combination of the degree of fire effects on vegetation and on soil properties.

Fuels – Living and dead parts of trees and shrubs, organic material and surface material that can readily burn in a wildfire.

Fuels treatment – The rearrangement or disposal of fuels to reduce fire hazard or to accomplish other resource management objectives.

Landing – A cleared area in the forest to which logs are yarded or skidded for loading onto trucks for transport

Major watershed (sub-basins) – Fourth-level Hydrologic Unit Codes (HUCs), as defined by the U. S. Geologic Survey. Formerly known as 'cataloging units'.

Point Source Pollution: Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Nonpoint Source Pollution- Nonpoint source pollution comes from many diffuse sources and is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters and underground sources of drinking water. Examples of these pollutants include: sediment, nutrients, bacteria from livestock and faulty septic systems and other toxic chemicals such as oil and grease (EPA-841-F-94-005, 1994).

Non-attainment areas – Geographic areas in which the level of a *criteria air pollutant* is higher than the level allowed by the federal standards. A single geographic area may have acceptable levels of one criterion air pollutant but unacceptable levels of one or more other criteria air pollutants; thus, an area can be both attainment and non-attainment at the same time.

Prescribed burning – The fire management technique of purposely igniting a fire in a vegetated ecosystem to restore forest health and to reduce fire hazard.

Scheduled timber harvest – The quantity of timber planned for sale during a specified time period from the area of suitable land covered by a land management plan. Scheduled timber harvest accomplishes the allowable sale quantity.

Sediment – Solid materials, both mineral and organic, in suspension or transported by water, gravity, ice, or air; may be moved and deposited away from their original position and eventually will settle to the bottom.

Skid road (skid trail) – An access cut through the woods for skidding.

Total Maximum Daily Load (TMDL) – A calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

Wildland fire – A lightning- or human-caused fire that is either being suppressed or, if lightning-caused, allowed to burn (see Wildland Fire Used for Resource Benefit). Often used synonymously with 'wildfire' or 'forest fire".

Yard – To convey logs or trees to a landing, particularly by cable, balloon, or helicopter logging systems.

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